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CONTRACT INCENTIVES
FOR
PRODUCT QUALITY

- FINAL REPORT -

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FOREWORD

This report presents the findings of an investigation performed to examine United States Air Force contracting and acquisition techniques utilized to assure the quality and reliability of weapon systems. It was performed by the International Technology Corporation (INTEC) at the request of the United States Air Force Business Research Management Center. The principal objective of the study was to examine the general motivational aspects of the USAF contracting techniques with particular attention to quality assurance and reliability policies, management techniques and practices.

The study methodology consisted of three phases: an examination of current quality/reliability policy; interviews with USAF procurement and contract administration officials and industry officials; and a wide-gauged industry questionnaire. The questionnaire was designed to obtain an industry-wide viewpoint of quality/reliability policy. Existing DoD policy was reviewed and a comprehensive literature review was undertaken to identify other research efforts in the product quality motivational arena. Following completion of these tasks, the results were integrated to determine what, if any, recommendations should be made.

The investigation resulted in the following primary recommendations:

- o Establish a central contractor product history file,
- o Adopt the proposed Cost Plus Award Fee (quality) methodology, and
- o Adopt certain recommended DAR revisions relating to motivational concepts for contracting.

Implementing documentation for each of the above recommendations is included in this report. In addition, a USAF Acquisition Managers Quality Guide was prepared and is included as a separate document.

We are indebted to the project manager, Major Lyle Lockwood, for his continuing technical consultation and assistance. In addition, we are sincerely appreciative of the assistance of all of the other Air Force and contractor personnel, who devoted their time and expertise during the period of this investigation.

The findings, conclusions and recommendations of this report should be viewed as a reflection of opinions of individuals surveyed and not as current or projected policies of the organizations participating in the survey. In addition, the comments, conclusions and recommendations of this report represent the professional views of the contractor who conducted the survey and do not necessarily represent those of the BRMC Office.

CONTRACT INCENTIVES FOR PRODUCT QUALITY

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I. GENERAL CHARACTERISTICS OF THE DEFENSE
MARKET AND PROCUREMENT METHODOLOGY

I. GENERAL CHARACTERISTICS OF THE DEFENSE MARKET AND PROCUREMENT METHODOLOGY

A. GENERAL

An evaluation of industrial motives which cause the firm to participate successfully in the Defense market must include an examination of the market and its peculiar characteristics. The FY 1980 Department of Defense budget contains projected expenditures of \$35 billion for procurement. Another \$13 billion was projected for research development tests and evaluation making a total of \$48 billion. The magnitude of this market is sufficient attraction in itself to cause contractors to wish to participate in it. There are other factors as well. Some examples include: high technology transferable to commercial products, relatively low risk market, diversity, patriotism, the only market for the firm's product line and prestige. A collateral benefit is the development and training of management and engineering personnel. These factors, and others combined with market size continually attract firms to participate in the Defense market.

B. DEFENSE MARKET CHARACTERISTICS

The "classic market" is characterized by producers with products that are ready and deliverable and buyers who decide, based on the characteristics of the product and their needs, whether to buy or not. The buyer/seller confrontation results in a quick and firm decision on price, and failure of the product once procured will have an immediate and negative impact on the survivability of the producer.

The Defense market, in general, and certainly in the case of systems, differs partly from the classic market approach due to the frequent utilization of an administrative determination of price based on costs incurred by the contractor, i.e., cost reimbursement contracts. It differs also in that the product may only be definable in general terms, thus creating technical uncertainties which may lead to major difficulties. Also, the producers responsibilities tend to be limited by these same uncertainties. The user of the product is not the buyer and the diversity of the use environment makes the application of warranty type of penalties difficult to manage equitably. The Defense market is also different in that the products are often unique and not directly saleable in the general market. In some cases though, technological advances may be made which are transferable to the private sector thus providing a competitive advantage in that market and a possibly important motivation to participate in the Defense market.

All of these and other unique characteristics have resulted in a variation in the classic market model. This unique defense market has led to the emergence of a group of firms who have adapted themselves to defense market characteristics and have specialized in their activities so that they can operate successfully. In the defense environment many of the successful government contracting firms are elements of major firms who are also successful in the traditional commercial market place.

The military/government procurement process is subject to several stresses. First is the inherent requirement for purchasing officials to be responsible in procurement actions and to be responsive to the public trust which falls to public servants who expend government funds. Second is an accompanying obligation to operate in a framework of absolute fairness as opposed to the competitive situation. Thirdly, there is a continuing broad and high level review of, and variation in, procurement policy as a result of changing political emphasis, e.g., total package procurement, incentive contracting; and "fly before buy." There are also reviews of particular procurements which may be required in response to special requests from other government officials.

A continuing emphasis of the Defense Acquisition Regulation (DAR), is embodied in the clearly stated premise that profit is the prime motivator, accompanied by unstated but well established punitive motivational concepts as evidenced by such clauses as Liquidated Damages. Positive and punitive methods for motivating contractors have historically been major alternate motivational elements of the free market system. They have traditionally been successful as motivating approaches to assure the delivery of conforming material, delivery on time, and at the agreed upon price.

The free market concept as it applies to system procurement, has been discounted by other researchers, as stated by Frederic M. Scherer ... "attributes of weapons acquisition preclude reliance on anything like a conventional market system for the procurement of advanced weapons, evoking instead what is best described as a non-market, quasi-administrative, buyer-seller relationship. In this non-market environment, the autocratic guides and restraints provided by the market's 'invisible hand' are absent. To replace them the government must deliberately structure its relations with contractors in such a way as to assure successful weapons program execution."¹

C. AEROSPACE MARKET CHARACTERISTICS

The American airfleet is comprised of three major segments. The first is the commercial air carriers and is about 2,500 aircraft, the second is the military airfleet of approximately 20,000. The largest is the general aviation group of private aircraft of approximately 161,500, divided between recreational aircraft and private aircraft operated by business or other types of users. The total market then represented by the American general aviation airfleet comprises about 184,000² aircraft. This does not include the foreign market.

The Federal Aviation Administration (FAA) is the principal arm of government which controls the design and manufacture of aircraft and associated

¹ Scherer, Frederic M., Weapons System Acquisition Process: Economic Incentives, Boston: Harvard University Press, 1964

² Graham, L. J., Retterer, B. L., Airline Procurement Techniques, ARINC Research Corporation, 1976

subsystems. The FAA authority derives from the Federal Aviation Act of 1958 which established the authority of the agency for the safe and effective operation of the national aviation system. Several missions are assigned the agency which impacts those manufacturers who are in the aviation market place. Principal FAA quality assurance missions are:

- o Type certification of aircraft which confirms that aircraft designed for civil use meet FAA standards of construction and performance.
- o Production certificates which attest to the manufacturers' ability to duplicate the design under an FAA approved quality program.
- o Air worthiness certification which is required of every airplane that is produced.

These responsibilities of the FAA do not apply in total, of course, to the military aircraft market. However, they do have a definite impact on procurers of aeronautical equipment purchased by the Air Force Systems Command (AFSC) and should be considered as an asset to military purchasers of these equipment.

D. AVIONICS

The avionics market supplies both the military and private sectors. The private sector is divided into two subgroups (commercial and private aircraft). Private aircraft is further subdivided into business, e.g., corporate aircraft and recreational aircraft.

Avionics may be described as a high technology, labor intensive product. Avionics equipment technology has been revolutionized since World War II. The advent of solid-state amplifiers replacing vacuum tubes is only the top of the technological iceberg that the avionics industry has encountered. Foreign products have penetrated the market providing American firms a strong incentive to excel technologically and to drive prices down.

Military procurements frequently attempt to expand the known performance limits possible with existing technology and the military market often buys in large quantities as well. This is in contrast to the airline market where most carriers purchase in small quantities to meet annual demands. The private sector is also more willing to settle performance wise for current state-of-the-art, or perhaps slight advances. The civilian market is also highly predictable and the procurement process is more straightforward. The market for civilian avionics is more likely to be concentrated on form fit and function, i.e., interchangeability and reliability. It also carries with it considerable support services such as warranty work, spares provisioning, training, and on-site technical assistance.

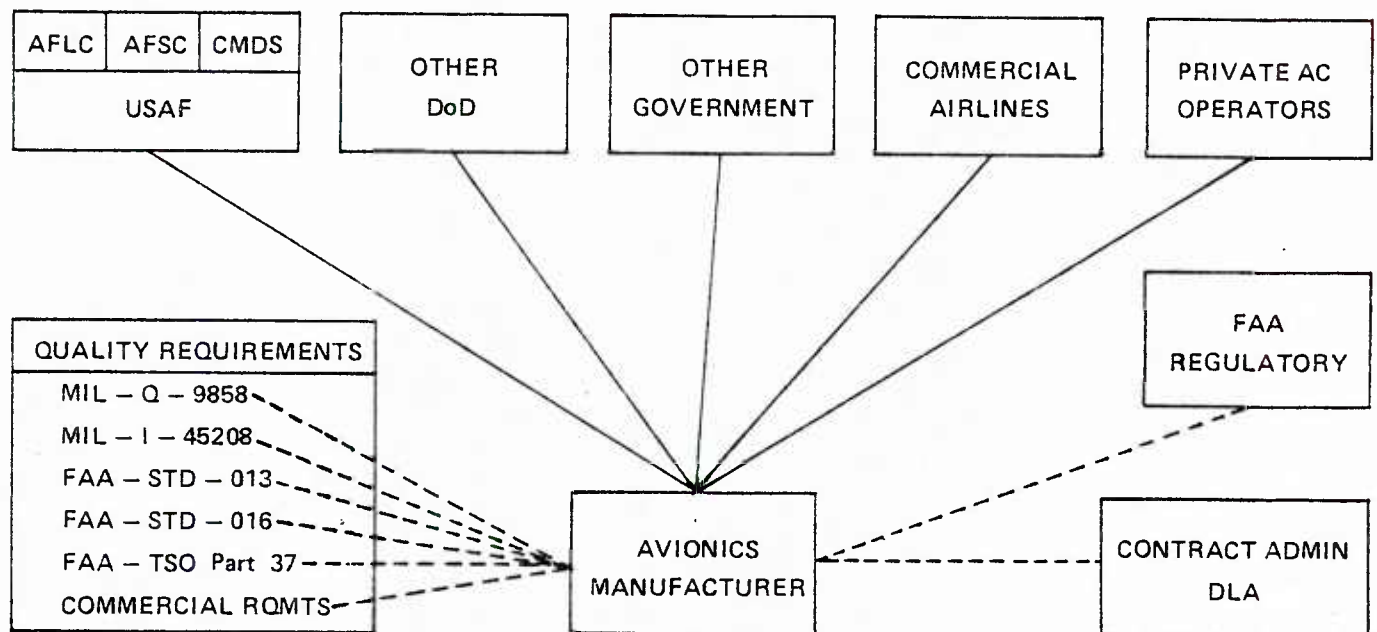
A major difference is the tendency for the air carrier to stay with a single supplier and to cooperate closely with that supplier on finding solutions to significant technical difficulties that may arise. In short, the civilian market is based on assuring the availability of the function the equipment provides rather than, as in the military case, simply providing

a product. The civilian market is far more interested in a product that will continue to operate whereas the military is often driven by "state-of-the-art" advancement requirements and the necessity to field systems which avoid early obsolescence. The military environment is one of technical competition wherein the objective often is to leap-frog the technology of the newest existing system.

The USAF purchases equipment for various reasons throughout the life cycle including the following: (1) for incorporation into systems in the development/production phase, (2) for replacements for fielded systems beyond the development phase, and (3) for a multiplicity of applications in other than weapon systems. The equipment is bought as well by other DoD organizations and by other government and non-government organizations. The posture of the avionics producer relative to its customer regulatory environment may be seen in Figure I-1.

Figure I-1

Relationship of Avionics Manufacturer
to Customer/Regulatory Environment



The customers shown in Figure I-1 seek to have some control over the development production processes that will provide some assurances that the equipment will function within predetermined operational parameters, e.g., frequency, power and sensitivity. This is frequently furthered by specifying a specific technical discipline and manufacturing procedures/processes that will assist in assuring that the equipment has a high probability of performing the function successfully. The avionics manufacturer's customers generally force an acceptance of agreed upon procedures as a condition of the procurement being considered.

Before a manufacturer can produce an avionics product to be used on civil aircraft, authority must be granted by the FAA. The authorization is issued based on conformance with FAA Regulation, Volume 2, Paragraph 37 and the Applicable Technical Standard Order (TSO). The TSO contains minimum performance and quality control standards for equipment to be used on civil aircraft. Once the TSO has been granted, the manufacturer must produce the equipment in accordance with his application, conduct all required tests and inspections and establish and maintain a quality assurance system adequate to assure the equipment meets requirements. At any time, the manufacturer is subject to inspections of his quality control system, his manufacturing facilities, and his records by the FAA.

In addition to the FAA regulatory enforcement activities described above, the FAA has its own quality assurance program for material/equipment purchased for its own use. These programs are described in FAA Standards 013, 016 and 018. Enforcement instructions for quality assurance personnel are described in FAA Orders 4630.8 and 4453.2A. The FAA quality assurance programs are largely based on the military programs, e.g., MIL-Q-9858.

E. BUYING OFFICES

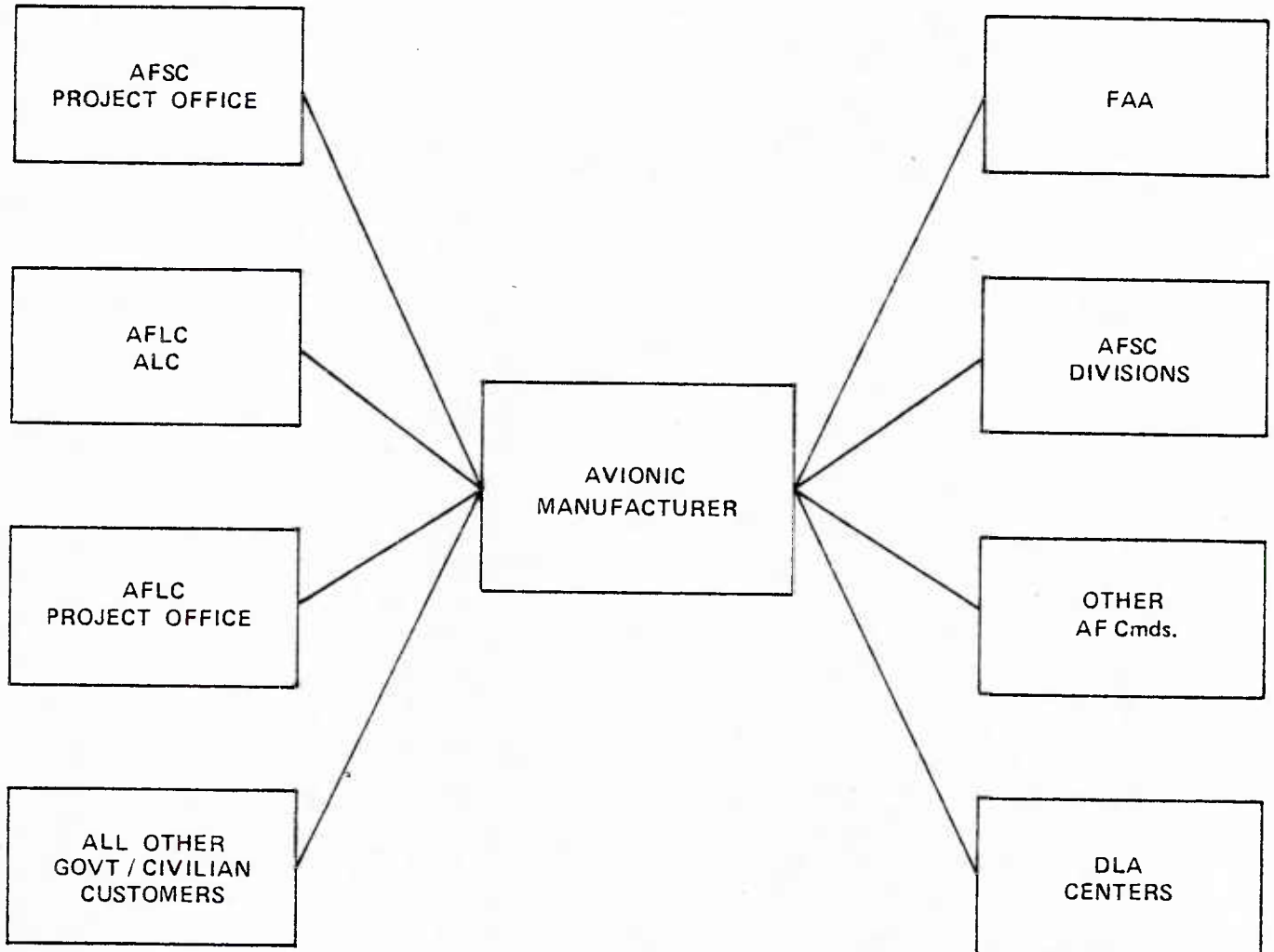
The procurement of avionics for Air Force purposes is frequently managed at the plant level by the Defense Logistics Agency. The Defense Logistics Agency enforces whatever requirement the Purchasing organization includes in the contract. It is done in accordance with the DLA in-plant manual, DLAM 8200.1. The procurements in any given avionics manufacturing facility may come from several sources outside the AFSC including AFLC and several AFSC division offices as well. These relationships are depicted in Figure I-2.

The intensity of management control from the various purchasing offices covers a wide spectrum of interests and controls. A project office facing a system schedule will have a different perspective than an Air Logistics Center (ALC) supporting a deployed system. The urgency of need is manifested in varying degrees of pressure exerted on the manufacturer. (However, it is unlikely that government purchasing offices will exert the pressure that the commercial airline will that has negotiated a clear warranty and has operational aircraft grounded due to a failure.) In commercial cases, warranty claims are expeditiously processed on a daily basis and supplies, repair costs, and turn-around time carefully monitored. This can be contrasted to military warranties and the protracted negotiations that surround them.

The procurement and contract administration process in the private sector are far less complicated and protracted than in the military sector. While there is considerable upstream activities, particularly in developing new products, the commercial purchasing group controls the process subsequent to the development of the preliminary specification. Assistance or involvement of customers in the manufacturing environment concentrates primarily on problems of performance or application as opposed to manufacturing practices. Quality assurance personnel are mainly interested in the reliability and maintainability of the product. Quality assurance activity in the pre-contractual period is most predominant in the proposal evaluation and performance evaluation stages.

Figure I-2

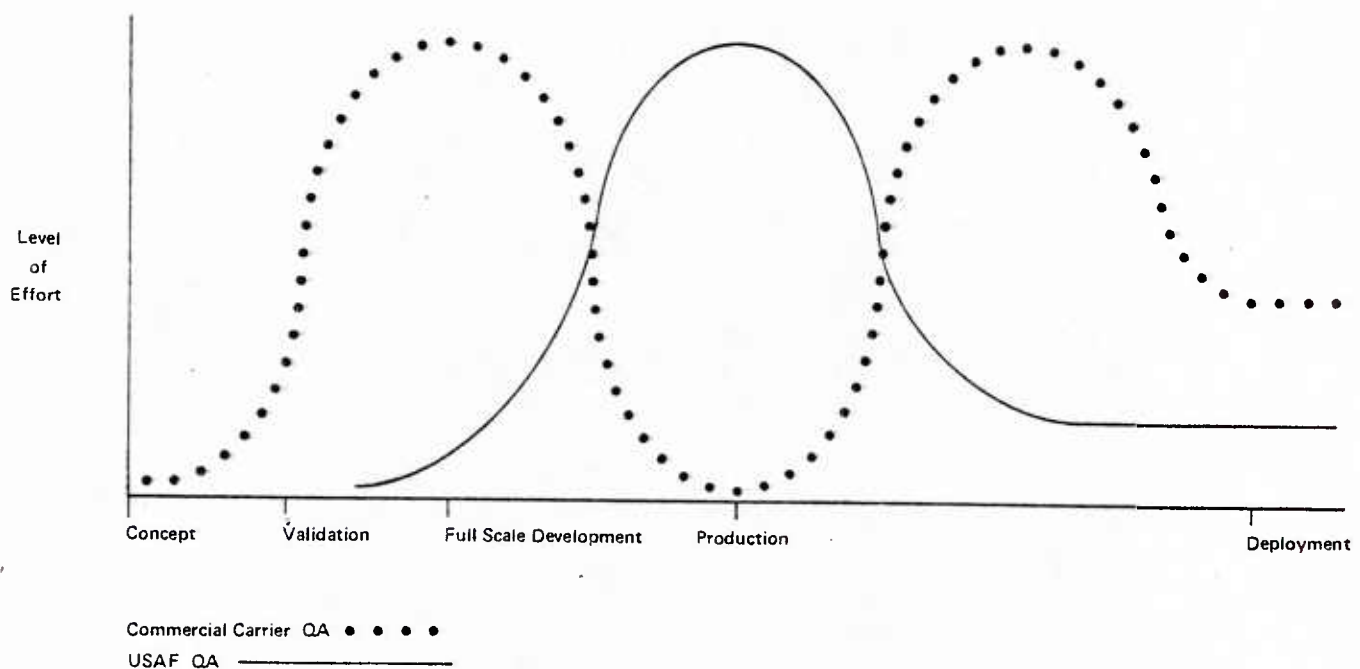
Relationship of Avionics Manufacturer to USAF and
Other Customer/Regulatory Groups



After product delivery, quality assurance monitors performance of product against the warranty. There is limited quality assurance involvement in the manufacturing process. In the event of performance levels not being achieved, quality assurance analysis may lead to modifications or other recommendations. There is notable contrast here in emphasis as compared with government purchasing offices, including the FAA, but particularly with DoD/USAF offices who concentrate on what might be called the industrial/manufacturing practices aspects. Figure I-3 below illustrates that commercial airline quality emphasis is relatively great in the early phases of the life cycle with considerable involvement after deployment. The commercial carriers reliance on FAA controls permit quality assurance personnel to devote more emphasis in the early phase and the later emphasis reflects their involvement in the warranty process. This phasing of effort is in obvious contrast to the USAF concentration of activity in the production phase.

Figure I-3

USAF Versus Commercial Quality Assurance Level of Effort



F. IDENTIFICATION OF PRODUCT CATEGORIES

The selection of product categories is important to this study in that it provides a baseline, or focus about which to build an analysis of current field performance and contractor motivational considerations in relation to contracting methodology.

The elements of AFSC that were initially under study included the Electronic Systems Division, The Aeronautical Systems Division, The Armament Division, The Space Division and The Ballistic Missile Office. A review of commodities purchased by those commands shows that in excess of 100 classes of equipment are being procured.

Review of the classes showed that they could successfully and logically be organized into a smaller number of subgroups. These subgroups are electronic, air frame, propulsion, armament and mechanical. The mechanical subgroup was dropped initially since it became apparent that many mechanical devices were associated with air frame or (vehicular body structure) or electronics or propulsion and are developed and purchased under the central direction and control of the air frame contractor. Armament systems also contain a large element of electronics and although mechanical components are included, they are considered to be relatively minor in terms of unique contracting procedures. The air frame group seemingly offered what appeared to be an opportunity for measuring the impact of contractual quality motivators, particularly with respect to subcontractors. The availability of ready data, however, reduced the priority of this subgroup below the remaining two subgroups, electronics and propulsion.

Electronic devices permeate practically all system components, however, it is most typically represented by avionics and it is here that much innovative development of testing and procurement approaches has occurred. While the propulsion system has less electronics than any other subsystem, even it has some dependence on electronic controls. This subsystem stands out as a mechanical device about which major procurement and testing techniques have been developed. For these reasons, avionics and engines were believed to offer the best opportunities as the product categories used for studying procurement methods, and contractor motivators related to quality and reliability. Accordingly, they are used as examples throughout the balance of this section.

G. REPRESENTATIVE FIELD QUALITY AND RELIABILITY LEVELS

In an ideal world, one would satisfy the objectives of this study by: identifying the contracting methodologies used for a variety of programs; analyzing the market conditions under which the contracts were negotiated and administered; evaluating the resultant quality levels achieved; and selecting those existing or required new methodologies which will provide the maximum motivation to the contractor to produce high quality equipments/systems. The realities of the actual procurement situation, however, are far from being clear cut. Although the written contracting methodologies for a group of contracts can be researched and documented, only the customer and contractor program managers on each contract can begin to construct how effectively the written word

was enforced, bargained away, circumvented, treated adequately or superficially, or even gambled upon in the face of contrary technical data that strongly suggested that inadequate performance is to be expected. The market conditions may be analyzed but the response of the customer and each contractor to the stimuli based upon these conditions is unique and will change differently with respect to time. Finally, the development of a non-ambiguous measure of resultant field quality which is relatable to the success or failure of a contracting methodology is far from straight forward.

In the realities of system performance, the only currently available practical measure of field quality and reliability levels is mean time between failure. On this premise, steps were taken to receive failure data from AFLC as reported in the D0 56 Product Performance System Data products. It was further intended that data would relate not only to engines and selected avionics subsystems or components but would relate to different types of aircraft as well. The results and findings of this investigation were as follows:

1. Avionics

In the case of electronic equipment, the data was examined for the following aircraft: A7, B52, C5, C130, F4, F5, F15, F16, F111, and T39. Further examination of the data showed such dispersions of reliability figures between aircraft that analysis based on the D0 56 product would need to be supplemented by extensive visits and communications with both producers and users. These dispersions are due to numerous factors including but not limited to the following:

- o The equipment interfaces in different aircraft cause variances in failure rates
- o Mission differences result in varying environmental stress applications
- o Varying competence levels of support activities
- o Applications of equipment in environments which were unknown by the designers and, therefore result in different failure levels
- o differences in failure reporting and feedback effectiveness.

In recognition of the interfaces between policy and product quality (reliability) and the continuing high level interest in reliability and the risks inherent in utilizing 66-1 data as the only data source, it was determined to utilize data made available from the Rome Air Development Center.³

³ Rome Air Development Center, Operational Influences on Reliability, RADCR TR 76-366, December 1976

The data in this report was the result of an investigation which extended over almost two years utilizing AFM 66-1 MDC system data, AFM 65-110 data, K051 system data products and the DO 56 Product Performance System Data products. Logistics performance factors were obtained using the method described in AFLCM 800-3.

The data base used for this study represented sixteen different items of USAF avionics equipment in operational use on ten different USAF aircraft weapons systems. Since many of these equipments are used on two or more different weapons systems, a total of thirty different applications (combinations of equipment and weapon system) were included in the study.

A matrix indicating the equipment items and the applications on each of the systems is presented in Table I-1

Table I-1

Equipment/Weapon System Combinations

NUMBER FUNCTION		EQUIPMENT/WEAPON AND SYSTEM COMBINATIONS									
		A	B	C	D	F	H	J	K	N	P
		SAC	TAC	MAC	ATC	SAC	ADC	SAC	TAC	TAC	TAC
1	Comm	0	0	0			0		0	0	
2	Comm										0
3	Nav	0			0						
4	Nav		0	0							
5	Radar		0								
6	Radar	0							0	0	
7	Radar									0	
8	Radar										0
9	Radar									0	
10	Nav/Radar						0				
11	Nav/Radar	0							0	0	
12	Nav/Radar	0								0	
13	Nav/Radar					0		0			
14	Instr			0							
15	Nav/Radar					0		0			
16	Instr			0							
TOTAL EQUIPMENTS		5	3	4	1	2	2	2	3	6	2

Table I-2 presents a summary of field MTBF values for the 16 avionics equipments. For reference purposes, the required MTBF values are also shown along with various ratios of predicted, demonstrated and field MTBFs as well as the MTBF actually experienced in the deployed equipment.

Table I-2
Avionics Equipment MTBF

EQUIPMENT NO.	REQUIRED MTBF	<u>PREDICTED</u> REQUIRED	<u>DEMONSTRATED</u> REQUIRED	<u>FIELD</u> REQUIRED	FIELD MTBF
1	450	2.43	1.23	0.44	198
2	1500	0.94	1.00	0.32	480
3	1000	2.90	0.67	0.14	140
4	700	3.71	1.25	0.51	357
5	30	1.10	1.25	0.63	19
6	193	1.48	1.06	0.64	124
7	83	2.25	1.59	0.32	27
8	75	3.44	1.21	1.54	115
9	475	3.00	1.72	0.11	52
10	600	1.05	0.96	0.21	126
11	770	4.27	1.30	0.46	354
12	300	2.25	1.35	0.37	111
13	140	1.01	1.32	1.53	214
14	380	3.81	1.42	0.60	228
15	900	0.98	0.99	0.62	558
16	1040	1.28	0.59	0.55	572

2. Propulsion

MTBF values for the jet engine category were developed from the six month period ending in March 1980, from the D0 56 Product Performance System Data Products. This data was drawn directly from the report without the benefit of the extensive background data available for the avionics analysis. It is expected that many, if not all, of the same factors affecting the MTBF relationships of the avionics category also have some impact upon the engine category, although the impacts of these factors may be different and there may also be additional factors as well. The engine MTBF values are shown by aircraft type in Table I-3 below.

Table I-3
Field MTBF Values by Aircraft Type

Aircraft	Engines	MTBF	Operating Hours
T-38	J-85	155	140,111
C-5A	TF 39	2786	25,075
F-4	J-79	34	3,739
F-4E	J-79	8321	66,566
F-5	J-85	153	1,375
F-15	F-100	17	46,188
F-111A	TF-30	495	8,413
F-111F	TF-30	360	9,729
F-111D	TF-30	275	9,340
F-105	J-75	8158	16,315
F-100	J-57	85	85
F-16B	F-100	2942	2,942
B-52G	J-57	177	30,805

Reliability is the established method for specifying and measuring time and performance relationships. It is also recognized that unanticipated operating failures account for a large proportion of support costs. In RADC TR76-366, it was observed that maintenance actions attributable to avionics equipment account for only 61 percent of the life cycle costs while maintenance actions on interface and related hardware accounted for the other 39 percent. This demonstrates that 39 percent of equipment support cost could not be eliminated even if there were no avionics failures. This is obviously an area where additional quality (reliability) management attention or policy may be advisable.

II. QUALITY AND RELIABILITY POLICIES AND PRACTICES

II. QUALITY AND RELIABILITY POLICIES AND PRACTICES

A. GENERAL

This part of the report includes an analysis of the quality and reliability requirements imposed both on the USAF by other organizations in the chain of command and by the USAF on subordinate organizations, specifically the USAF Systems Command.

The Quality and Reliability Assurances (Q&RA) policies are responsive to the Executive Office of the President as established in the Office of Management and Budget (OMB) Circular A-109 dated April 5, 1976. It is important to note that this circular was not the driving force which caused the Department of Defense and the U.S. Air Force to initiate actions to control Q&RA as the OSD and the military departments had recognized the importance of quality characteristics of products several years before. OMB Circular A-109 did signal a new high level of government interest in weapon system acquisition and identified the acquisition of major systems as "one of the most crucial and expensive activities performed to meet national needs. The circular identifies performance/demonstration/test characteristics, all closely associated with Q&RA, along with others that require attention by the program manager.

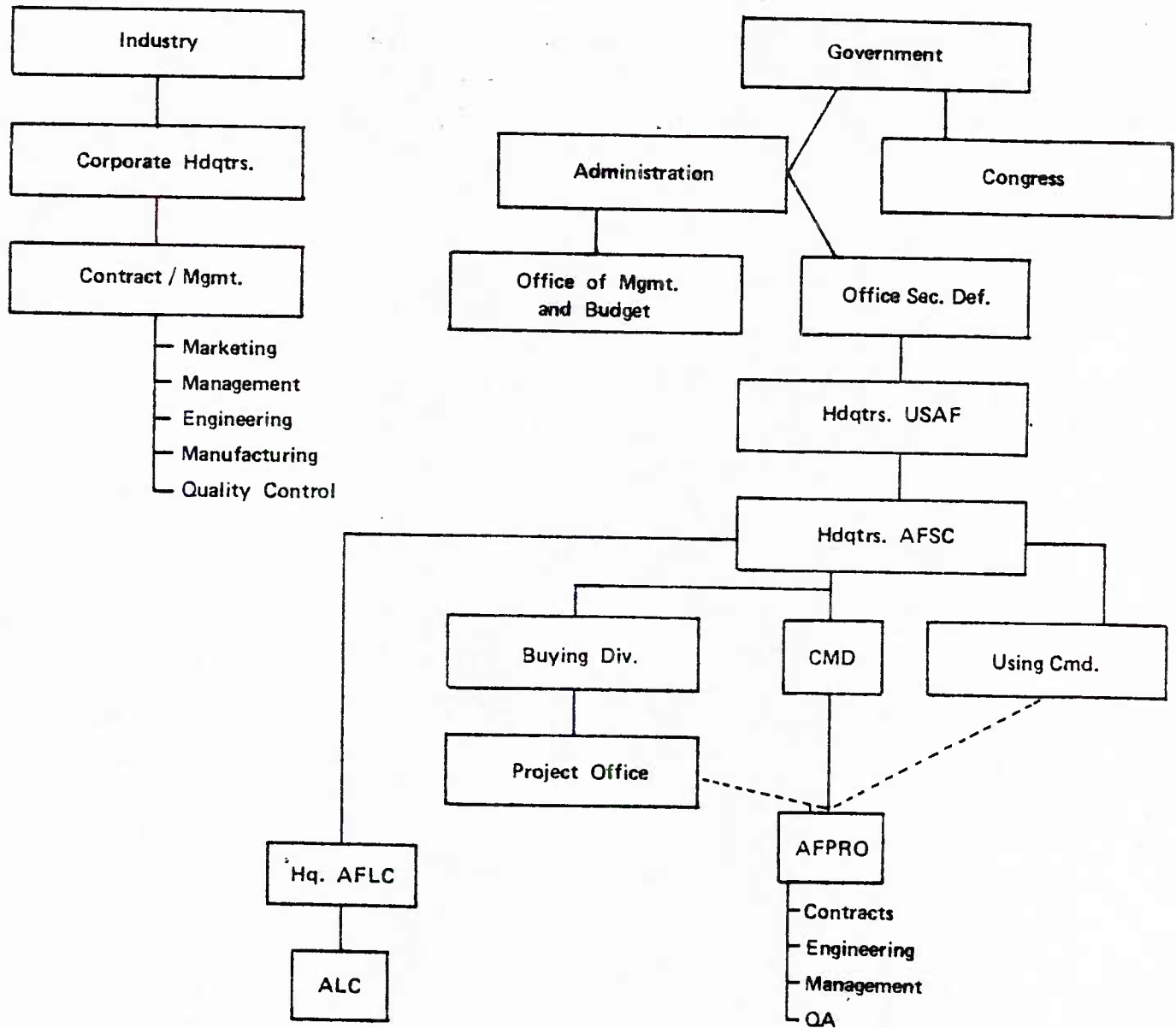
B. POLICY ORIGINS

A perception of quality depends on the viewpoint and interest of the observer. Likewise, quality policy is obviously affected by the views of those who write it. It is useful then to identify at the outset the various organizations which, at various stages in the system's life cycle, have an interest which waxes and wanes depending on their individual role in any particular system's life cycle. Figure II-1 below shows the principal observers of system quality.

There would be little significance in describing in detail the perspectives of all of the organizations involved other than to say that the issues that receive the most attention are system cost and overall performance goals. For the purposes of this discussion, cost will be discarded and performance remains as an overall quality surrogate or synonym. Performance requirements are ultimately defined in specifications or similar documents and range from broad system requirements such as speed, range, overall vehicle MTBF to specifications for elements of subsystems, e.g., UHF transmitters.

The Chief Executive and the Congress have a responsibility for allocation of national resources and for the defense posture of the nation. The interest of these principal elements at the highest levels guarantees that military personnel and departmental civilian employees will have a continuing interest in how quality (in terms of performance, including support costs), is specified and how well the objectives are being achieved. The in-plant quality assurance personnel interface daily with the contractors. They see quality primarily in terms of product conformance and their view is based on production perceptions. Logistics support personnel

FIGURE II-1
SYSTEM QUALITY OBSERVERS



including reliability and maintainability specialists represent another range of interest and are concerned with the frequency and costs of repairs which are functions dependent on product quality.

On the contractor's side, it is evident that the spectrum of observers is much smaller. Their span of interest, control and perspective may be briefly intensive then may erode quickly with time and other projects. However, quality

is vital to their survival which depends on their producing systems that are accepted by the contracting officers. Contractors have an inherent patriotic interest in their defense equipment performance as do government employees. There are other fiscal motivations as well since if government quality personnel do not accept their system, reimbursement will not be forthcoming and the firm may ultimately go out of existence.

C. GENERAL POLICIES FOR THE SPECIFICATION AND ATTAINMENT OF QUALITY

1. Quality

Quality is defined as "the composite of material attributes including performance, features, and characteristics of a product or service to satisfy a given need."⁴ By this definition, product quality includes reliability as one of the specified attributes, features, or characteristics of a product.

Product quality is specified when a technical description of the product is completed. The technical description may take the form of a military specification, a commercial catalog description, company part number or other description. The product description may also contain a modifier such as grade level. It may also simply consist of a description of performance goals which must be met.

In the case of major systems, the specification of quality begins in the pre-conceptual phase of the life cycle by a determination of what the performance parameters (including reliability) must be. In the initial specification of requirements, performance is negotiated and traded off between minimum operational requirements and life cycle system costs throughout the various phases of the life cycle until, in the full-scale production phase they are firmly established as technical requirements that must be met. These determinations of system performance requirements are made by the user and developing command. Deviation from these requirements must be approved by the appropriate operating command.

The quality assurance function as described in policy documents is principally to define specifications, standards, inspections, tests, training and certification requirements and evaluations required to control quality. It is also a quality assurance function to identify new developments in products or processes that will necessitate advanced planning of quality assurance activities.

Other specifically identified tasks in system development include the quality assessments to be performed before the end of the demonstration and validation phase and before the end of the full-scale engineering development phase. The purpose of the assessments are essentially to assure quality characteristics are identified and quantified and to assure there are plans for demonstration of conformance to quality requirements.

While most of the activity is related to administrative controls, the final result of all of these actions is the act of acceptance. Quality assurance personnel who normally perform the acceptance function signify by this action that all requirements, including performance characteristics, have been complied with.

⁴ DoDD 4155.1, Quality Program

2. Reliability

Reliability may be described as continuing performance (as specified) over a predetermined period of time. The official definition, is "the probability that an item will perform its intended function for a specified interval under stated conditions."⁵

The specification of essential reliability characteristics starts with the Mission Area Analysis (MAA) performed during the pre-conceptual phase. Reliability deficiencies of mission-related operational systems are noted then and the essential reliability characteristics of the new system under consideration are included in the Statement of Need (SON).

During the conceptual phase, reliability mission needs identified in the SON are translated into specific values relatable to program management. The terms are included in the system performance description and in operational and maintenance concepts. During this phase, the reliability goals are liable to tradeoff analysis and revision in conjunction with other system parameters.

The reliability goals of the conceptual phase are transformed into design goals which are pursued during the demonstration and validation phase. During this phase, prototype testing is performed and environmental stress information is provided for further design deliberations. Formal reliability demonstrations are not normally performed although planning for reliability testing in later phases does begin then. Effectiveness or cost tradeoff studies may be performed as a result of updated operational or maintenance concepts. Ultimately, the testing feedback and tradeoff efforts are expected to result in mature operational reliability thresholds and goals and in reliability requirements for inclusion in the Full-Scale Engineering Development (FSED) phase. The program manager must also prepare a reliability management plan.

The contract issued for FSED must have quantitative reliability requirements included in it and the requirement must be demonstrated in an operational test and evaluation (OT&E) environment prior to the start of full-scale production. The reliability management plan must be updated to support OT&E activities and deployment. By the end of this phase, reliability requirements complete with associated confidence must, if possible, be developed. These firm reliability requirements can then be incorporated into a production contract.

During production, testing is performed periodically to ensure that reliability values previously demonstrated have not been degraded. If there is evidence that reliability requirements are not being met, acceptance will be withheld pending satisfactory compliance.

D. POLICY DOCUMENTS

This section describes several policy documents which are used either singularity or in combination within the Air Force contracting and acquisition process to define, specify and manage quality and reliability requirements for products and systems acquired by the Air Force.

⁵ MIL-STD 721B, Definition of Effectiveness Terms for Reliability, Maintainability, Human Factors and Safety

1. Office of Management and Budget (OMB)

Circular A-109 was followed by OFPP pamphlet No. 1 published by the Office of Federal Procurement dated August 1976 which was prepared to further describe the intent and application of A-109. In turn, the existing DoD Directives 5000.1 (Major System Acquisitions) and 5000.2 (Major System Acquisition Process) were revised to assure consonance with the OMB policy.

2. Office of the Secretary of Defense (OSD)

a. Overview of Principal Directives

While these documents contain the basic system acquisition guidance from the OSD, the fundamental quality assurance policy is contained in DoDD 4155.1, Quality Program and in the Defense Acquisition Regulation (DAR). As in the cases of DoDD's 5000.1 and 5000.2, 4155.1 has been revised to more directly reflect some of the system strategy concepts embodied in Circular A-109.

b. DoD Directives 5000.1, 5000.2, 5000.3 and 4155.1

Of these documents, DoDD 4155.1 treats quality assurance management in detail, while 5000.1 and 5000.2 treat product quality and reliability only in very broad terms. DoDD 5000.3, Test and Evaluation, establishes the DoD policy for the conduct of the test and evaluation during the acquisition of Defense systems. At this stage in the regulatory process, guidance is too broad to include specific instructions. The general guidance provided is that major systems shall be developed in a structured cost-controlled process in which a series of pre-designated program issues must be addressed in making recommendations to the Secretary of Defense to proceed or not to proceed with development of the system. Major systems are defined as those involving or anticipating a cost of \$75 million dollars in research, development, test and evaluation (RDT&E) or \$300 million dollars in production.

c. DoDD 4155.1

DoDD 4155.1 (Quality Program) provides a broad charter of policy and objectives. In essence, it establishes the requirements for each of the DoD components to develop a cost-effective quality program which will assure that DoD material both conforms to specified requirements and provides user satisfaction.

There is no OSD counterpart directive that provides policy and/or objectives in the related areas of reliability, maintainability and other similar disciplines.

While DoDD 4155.1 is a very broad policy document, Paragraph C-6 is concerned specifically with the system acquisition process and the product quality issues alluded to in DoDD's 5000.1 and 5000.2. System program managers are assigned "responsibility and accountability" for the "quality, reliability and maintainability" of their products. The following system-related requirements are identified in Paragraph C-6:

- o Quality characteristics be specified and designed into the product;
- o Characteristics be quantified whenever possible;
- o Critical application items are identified and controlled;
- o Quality and technical requirements be achieved;
- o Test and evaluation be performed to assure conformance;
- o Design reviews and independent assessments be performed before completion of each milestone and actions be taken on deficiencies revealed; and
- o A copy of the assessment report be made available to the head of the DoD component concerned.

3. United States Air Force

a. AFR 74-1, Quality Assurance Program

AFR 74-1 expands on the broad policies and specific responsibilities in DoDD 4155.1. It establishes clear quality assurance management requirements principally in the areas of (1) design and development, (2) contracting, (3) contract management and (4) logistic support, and generally sets forth USAF quality assurance policy. This is somewhat of a variation from DoDD 4155.1 which is written in terms of policy objectives and responsibilities without regard to differing management functions based on mission responsibilities.

Insofar as the DoDD 4155.1, Paragraph C system requirements are concerned, they are restated in AFR 74-1 and imposed on AFSC in Paragraph 3-D. Specifically, one assessment to assure the objectives have been achieved is to be made before the end of the Demonstration and Validation phase and one before the end of the Full-Scale Development phase.

In summary, AFR 74-1 is primarily concerned with management objectives and roles. As a consequence, the quality assurance management system concepts and approaches to controlling product quality provides limited technical product performance oriented instructions. This is in some contrast with AFR 80-5 in which product performance is the predominant consideration.

At the command levels, it is clearly established that each acquisition, modification or integration program must have a program manager with specific hardware oriented R&M functions to perform.

b. AFR 80-5, Air Force Reliability and Maintainability Program

AFR 80-5 outlines the policy for managing the Air Force reliability and maintainability program for systems, subsystems, equipment

and munitions. It applies to all Air Force activities that manage such equipment in any phase of the life cycle.

This directive, as AFR 74-1, provides comprehensive management instructions designed for the Command level, e.g., Systems Command/Logistics Command. While it is similar in that it describes a total Air Force program, it is more specific and more demanding in management requirements and in hardware specificity.

In management terms, Air Force headquarter's responsibilities are outlined in AFR 80-5 from both a technical and a policy viewpoint. From a technical viewpoint, it is required that the AF headquarter's element assure that R&M or at least mission critical parameters be included in each Program Management Procurement (PMP). It is also required that a program element for general R&M technology improvement, engineering application, and control be maintained. From a management viewpoint, policy is established and offices of primary responsibility assigned. In addition, responsibility for an AF wide R&M education and training is established and waivers for program exclusions are controlled.

In summary, AFR 80-5 contains a significant amount of specificity covering equipment in R&M terms. It provides R&M related actions in some detail that are to be performed in each life cycle phase. It incorporates specific R&M performance reports under established Reports Control Symbols.

c. AFCMDR 74-1, Procurement Quality Assurance Program

Air Force Contract Management Division Regulation (AFCMDR) 74-1 establishes policies and procedures for use by CMD personnel in those major facilities that have not been assigned to the Defense Logistics Agency for administration and have been retained for administration by the USAF. There are other documents which have an impact on its usage such as MIL-STD 1520 and MIL-STD 1535. However, it provides a view of the philosophical concepts which guides USAF in-plant quality assurance activities.

AFCMDR 74-1 has been in existence in various forms for several years. It embodies the Contractor Responsibility Concept and is predicated on assuring that the contractor has a comprehensive quality program and that conforming material only is offered for acceptance. The regulation has much in common with the Defense Logistics Agency and Army and Navy in-plant quality assurance documents.

Plants manufacturing USAF systems have traditionally been large facilities, due to the types of equipment being produced, e.g., aircraft. It was reported in July 1977 that contractor quality assurance personnel comprised over 14,000 persons while USAF quality assurance numbered 1,185 persons. These figures are considered to still be accurate since there were reported to be 1,184 AFCMD personnel in November 1979.⁶ This is a ratio of nearly one to 12.

AFCMDR 74-1 reflects the Contractor Management System Evaluation Program (CMSEP) which is based on evaluating contractor management as a system for effectiveness, adequacy and compliance. While superficial views of documents

⁶ Weiss, Bernard L., Observations and Recommendations to Enhance Product Quality in the Operational Environment (Quality Horizons), Air Force Systems Command, 1979

such as AFCMDR 74-1 may be misleading, it is clear that it is based on general system or industrial controls with less emphasis on product quality in the sense of product reliability. There is a brief treatment of quality assurance in system acquisition in Chapter 2 which is largely references. Of the three elements of quality, i.e., quality of design, quality of conformance, quality of contractor's quality assurance system, the basic thrust of the AFCMDR 74-1 is to deduce quality of conformance from quality of system tests, while quality of design is essentially untreated.

AFCMDR 74-1 represents the most recent revision to what has become a standard concept, consistent with DoD policy, of how to assure product quality through continuing evaluation of the contractor's quality assurance program. This approach, which to some extent is dictated by both policy and manpower limitations, results in limited product inspection effort and fits into the overall CMD concepts of contract administration.

4. Defense Acquisition Regulations (DoD)

a. General

The DAR is distinguished from the Directives discussed previously due to its prominence in the procurement hierarchy. It is seen as more than policy since it also contains not only instructions that are to be followed when contracting but also contains specific clauses, forms, etc. that are to be included in contracts as well. The DAR establishes the general procurement arena in which major systems, as well as all other military procurements take place.

The purpose of the DAR is to establish, "for the Department of Defense, uniform policies and procedures relating to the procurement of supplies and services under the authority of Chapter 137, Title 10 of the United States Code, or under other statutory authority."⁷ The net result to be found in the DAR are the policies and procedures that personnel follow who are involved in the procurement of supplies including the administration of contracts. The DAR establishes the tone and perspective of the DoD and Congress across the entire spectrum of purchases made ranging from personal troop support equipment to major weapons systems.

Also included in the DAR are necessary presumptions about the DoD market place. These include assumptions of the market insofar as what will make DoD procurements attractive to producers and what contract characteristics will cause those firms to produce material on schedule at the agreed upon cost and in conformance with all requirements.

In order to evolve a cohesive, effective and universal procurement approach, the DAR identifies and describes several forms or modes of contracts, e.g., Fixed Price, Incentive, etc. that will be used in various contracting situations, e.g., Research and Development and Production. For the established framework of contract types, specific clauses are included which establish binding contractual terms and conditions. The DAR also describes various government roles and responsibilities inherent in the contract such as identifying Contract Administration versus Procurement functions and provides instructions as to what type of clause is to go in what type of contract.

⁷ DAR 1-101

For the purposes of the investigation into contracting methodology related to product quality, there is one major assumption contained in the DAR, Paragraph 3-401(a) and Paragraph 3-808.1. This assumption is that the profit made on a particular contract will be reflected in the quality of material delivered.

b. The Role of Profit

(1) DAR 3-401(b)(1)

"Profit, generally, is the basic motive of business enterprise. Both the government and its defense contractors should be concerned with harnessing this motive to work for the effective and economical contract performance required in the interest of national defense. To this end, the parties should seek to negotiate and use the contract type best calculated to stimulate outstanding performance. The objective should be to insure that outstandingly effective and economical performance is met by high profits, mediocre performance by mediocre profits, and poor performance by low profits or losses. The proper application of these objectives on a contract by contract basis should normally result in a range of profit rates."

(2) DAR 3-808.1(a)

This general perception of the nature of business, is further amplified for the specific case of cost reimbursement contracts in the DAR, Paragraph 3-808.1 as follows:

3-808 Profit, Including Fees Under Cost-Reimbursement Type Contracts

3-808.1 Policy

(a) General "It is the policy of the Department of Defense to utilize profit to stimulate contract performance. Profit generally is the basic motive of business enterprise. The Government and defense contractors should be concerned with harnessing this motive to work for more effective and economical contract performance. Negotiation of very low profits, the use of historical averages, or the automatic application of a pre-determined percentage to the total estimated cost of a product, does not provide the motivation to accomplish such performance."

While it is not stated specifically, the assumption is the norm for a free market and accordingly, that is presumed to be the basic underlying DoD procurement assumption.

There are several types of contracts defined and prescribed in the DAR. In all cases, it is assumed that quality is a primary contract goal along with price and schedule and that the product will conform to requirements.

One basic DAR contract form is the Firm, Fixed Price contract. It is suitable for use when reasonably definite designs or performance specifications are available and a fair and reasonable price can be determined. However, another type of contract is cost reimbursement which provides for payment of allowable costs to the contractor and may also allow a sliding scale of profit based on some predetermined contract goal. One type of such contract is the Cost Plus Award Fee⁸ which provides a means of applying incentives to contract goals which are not susceptible to finite measurement, e.g., Contractors Quality Assurance Program. It is suggested that contractors could be encouraged to perform their quality programs to a higher degree of efficiency if specific profits were achievable and in addition to those negotiated as a profit base originally. This premise will be evaluated in a later section of the report.

Insofar as procurement is concerned there is a clear aura of public trust responsibility, which if examined, would include a requirement that the government agent/buyer did in fact, receive what it was that had been contracted for in the name of the public (government). This can simply be stated as an inspection function which is the genesis of DoD quality assurance programs.

While there are several principal sections of the DAR that bear significance when considering the DoD quality assurance program, Section XIV should be considered as basic.

c. Section XIV Procurement Quality Assurance

This section prescribes policies and procedures to assure that supplies and services procured by the Department of Defense conform to the quality and quantity set forth in the contract, and for the acceptance functions associated therewith. It is worth noting that the DAR is limited to procurement quality assurance; storage or maintenance quality assurance policy is not included.

Part I of Section XIV describes and defines in broad terms contractor and government responsibilities in terms of quality assurance. Since this part is not for incorporation into contracts, this guidance is intended for government personnel and establishes no contractual obligations. The part contains a matrix for selection of one of the levels of intensity of management described. In effect then, this part of Section XIV is the basis for providing instructions to procurement personnel as to what sort of a quality assurance management program to include in a contract.

Part 2 of Section XIV establishes the responsibility of the various concerned government organizations involved in the procurement process as follows:

- o The activity responsible for the product technical requirements is also responsible for prescribing "inspection testing or other contract quality requirements."
- o The Purchasing Office is responsible for "contractually formalizing requirements for quality."

- o The Contract Administration Office is responsible for performing government quality assurance actions (described in Section XIV, Part 4), and for reporting to the purchasing office any deficiencies in design or technical requirements including "contract quality requirements."

Part 3 of Section XIV, Contract Provisions, identifies clauses contained in Section VII, and provides guidance as to where procurement quality assurance actions will be performed. It also establishes policy concerning the responsibility for the product acceptance functions, when and where the product acceptance will be affected, and provides general guidance on certificates of conformance and small purchases.

Most importantly, it identifies specific contract quality assurance clauses for inclusion as contractual provisions. Some of these clauses can have a distinct impact on the performance and outcome of a contract and will be discussed further in the special clauses section of this report.

Part 4 establishes policies and procedures for the performance of the Procurement Quality Assurance task. This task is essentially the entire spectrum of determining if contractors have fulfilled their contractual obligation in terms of product quality. It reinforces the responsibility concepts in Part 1, particularly as they relate to the government quality assurance functions. Details are provided relative to planning and implementing the government actions in the contractor facility environment. The following actions are directed to be performed to "determine the contractors compliance with the contract quality requirements," (14-403):

- o Review and evaluation of the contractor's inspection procedure.
- o Review and evaluation of the contractor's selection, calibration, maintenance and use of gauges, measuring and test equipment.
- o Review and evaluation of the contractor's quality records.
- o Performance of product verification by the government.

There is other information in this part concerned with administrative considerations of manufacturing material and government actions in subcontractor facilities, government inspection stamps, and shipment of supplies. These considerations are outside of the primary concerns of this study and will not be discussed. The same observation is valid for Part 5, as well, since it is concerned with special commodities, i.e., subsistence, petroleum, and construction.

Section XIV is then limited to the procurement quality assurance process. It describes the various types of contractor quality assurance management options that are available and provides a guide for selecting one

for a particular contract. It establishes the basic DoD concept that the contractor is responsible for controlling product quality and offering only conforming material to the government for acceptance. It provides that the contractor may be penalized in the event the government is required to expend additional effort as a result of the necessity for re-inspection by the government. Section XIV basically provides intra-government management guidance, identifies standard inspection approaches and is built on the general premise of product conformance to established contract requirements.

In addition to Section XIV, quality considerations can be found in numerous places in the DAR where opportunities are provided for the use of quality information. Examples of such DAR references where product quality data can influence procurement actions include the following:

1-319(d)(Viii)(A)	Renegotiation
1-322.1(b)(3)(ii)	Multi-Year Procurement
1-326.4(b)(iii)	Breakout Guidelines
1-604.1(ii)(A) and (B)	Causes for Debarment
1-902	Responsible Contractors
1-1110	Qualified Products
3-401(b)(2)	Role of Profit (and Quality)
3-407.2(a)(2)	Contracts with Performance Incentives
3-801.3	Responsibility of Requirements and Other Logistics Personnel in Purchasing Offices
3-902.3(c)(i)(ii)	Make or Buy

d. Contractual Clauses

No quality assurance emphasis can be applied in a contract situation unless there is enforcing contract provisions or language. The DAR references above are solely for the guidance of government procurement personnel. Section XIV is fundamentally administrative guidance on how to manage the Procurement Quality Assurance task and as such deals to a significant extent with intra-government rules and interfaces. It does, however, lead to the selection of administrative quality assurance programs and specific clauses for inclusion into contracts. Due to the very wide and thorough understanding of some of the administrative management programs, e.g., Standard Form 32, MIL-Q-9858A, they will not be discussed in detail. However, the power inherent in some other of the clauses does make them worthy of limited discussion. Table II-1, at the end of this section, identifies numerous clauses that relate to the quality function. Some of the more significant ones are discussed in the following paragraphs.

DD Form 1155 (Provision No. 1 and Responsibility for Inspection Clause)

Those procurements that do not exceed \$10,000 are generally referred to in the DAR as "small purchases." Negotiated purchases of supplies not in excess of \$10,000 may be affected by the utilization of the DD Form 1155. Under certain conditions set forth in DAR 14-308, the DD 1155 may be used exclusively as the quality assurance clause. In this case the government

may rely fully on the contractor to use whatever quality control methods he believes to be appropriate for that particular product. There are several general provisions in this purchasing document, however, the first provision incorporates the responsibility for a contractor to perform the inspection and tests necessary to substantiate that the material conforms to contract requirements. In some cases, federal specifications may contain the standard Responsibility For Inspection clause (DAR 7-103.24) and may identify specific inspection requirements in Section 4 of the specification as well. There may also be drawings incorporated in the contract which identify inspection requirements and/or incorporate the Responsibility for Inspection clause. The use of the Contractor Responsibility alone is restricted to purchases under \$10,000. Guidance for the inclusion of these two clauses is contained in DAR 14-101.5.

Standard Inspection Clause

This requirement may be incorporated into contracts for commercial items or a military item that is not associated with a military operation. It requires that an inspection system be maintained which is acceptable to the government but does not describe in advance the essential characteristics of the system. It does, however, require the maintenance of inspection records and gives the government access to those records. The clause (DAR 7-103.5) contains other provisions including but not limited to the following:

- o The rights of the government and the contractor if non-conforming supplies are tendered.
- o Administrative instructions related to the government inspection function and the responsibilities and rights of the contractor and the government.
- o Contractual terms and conditions surrounding the acceptance functions.

Guidance for its inclusion in contracts are contained in DAR 14-101.5.C.

The inspection clause must be included in contracts for supplies which exceed \$10,000. There are three variations of the clause which are to be imposed depending on the contract form. The three contract forms are: (1) fixed price supply, (2) fixed price incentive, and (3) retroactive price redetermination after completion. Items (2) and (3) require the deletion of the paragraph concerned with government rights in the event non-conforming supplies are delivered and, in its place, substitute a different paragraph more suited to incentive or price redetermination types of contracts. The Inspection clause must be included when either of the two following requirements are imposed.

Inspection System Requirements

The DAR Inspection System referred to in Paragraph 14-303 is documented in the Military Specification MIL-I-45208. The determination of whether or not to incorporate it into a contract is provided by the DAR guidance in DAR 14-101.5.b. Basically, it is designed to be used when it is necessary to impose on the contractor a management system which will assure selected management controls will be used to control the process of inspecting

and documentation, measuring and test equipment process controls, and non-conforming material. The above include the principal areas that are specified, however, there are other functions as well that are of a lesser magnitude of significance.

Quality Program Requirements

The Quality Program Requirement is documented in Military Specification MIL-Q-9858. As in the case of MIL-I-45208, guidance for its inclusion in a contract is contained in DAR 14-101.5.b. MIL-Q-9858 is another quality management system but of greater scope than MIL-I-45208. It causes a manufacturer to control everything in MIL-I-45208 and the following as well--work instructions, control of subcontractors and quality related costs. Control of subcontractors was included in MIL-I-45208, in that inspection must be performed on subcontracted supplies, however, the MIL-Q-9858 requirement enforces significantly greater controls.

There are provisions and specific clauses in the DAR for the inclusion of the Inspection System and Quality program in the various types of contracts discussed above. It should also be noted that they are subject to modifications to fit a peculiar contract situation. The practice of modifying MIL-Q-9858A occurs most often in weapon systems and space system project offices. The Space and Missile System Organization has issued a directive, SAMS0 Std. 73-5B, Quality Assurance Requirements for Space and Missile Systems. Its purpose is to "delineate and interpret the requirements of MIL-Q-9858 for application to space and missile system procurements."

Inspection and Correction of Defects (Clause 7-203.5)

This clause is normally used in cost reimbursement type research and development contracts where the primary contract objective is the delivery of end items other than designs, drawings or reports. It incorporates certain elements that make it of particular interest to personnel concerned with the inspection and acceptance function.

It establishes or reaffirms the government's rights to inspect and test the product being contracted for to the extent practical, at all times prior to acceptance. It requires the contractor to maintain an inspection system acceptable to the government and establishes the right to inspect in a subcontractor's plant. It provides for expeditious final government inspection and acceptance after delivery.

The most important condition established in this clause, however, is the right of the government to require correction or replacement of non-conforming material for a period of up to six months after acceptance. In the event the contractor "fails to proceed with reasonable promptness to perform such replacement or correction," the government has the right, among other alternatives, to "by contract or otherwise perform such replacement or correction and charge to the contractor any increased cost." There are other penalties as well and the result is that this clause is a very potent contract term with the potential for causing serious repercussions to the contractor.

Liquidated Damages Clause (DAR 7-105.5)

This clause, like the Inspection and Correction of Defects clause, is of particular interest to quality assurance personnel as it provides a powerful incentive to contractors to provide material that conforms to requirements. In the event an inspector does not accept material, and the supplies or services are not delivered on schedule, the contractor may be forced to pay to the government a previously agreed upon amount for each calendar day of delay.

This clause is normally used in fixed price supply procurements by formal advertising and negotiation. It is used when a slippage in the delivery schedule will cause the government to suffer damages and the extent of the damage will be difficult to prove. When used it will be included as a part of the Default clause (DAR 7-103.11).

Material Inspection and Receiving Report (Clause 7-104.62)

This clause is incorporated in all contracts which anticipate the delivery of a separate and distinct object. This clause causes the contractor to prepare the DD 250 form which is normally signed by the QAR signifying compliance with all requirements and acceptance as an authorized government representative.

Title and Risk of Loss (Clause 7-103.6)

This clause is used in fixed price supply or fixed price research and development contracts. It is of particular concern to quality assurance personnel since it provides that unless there is specific exclusion elsewhere in the contract, title to the material passes to the government "upon formal acceptance."

When an individual checks the acceptance block on the DD 250 and signs as the authorized government representative, title for the material, device, or system passes to the government regardless of when or where the government takes physical possession. Subsequent to this action, the contractor may ask for payment for the material and present the DD 250 as all or partial evidence of conformance with contract requirements. Without this action the contracting office, under ordinary circumstances, may not recognize a request for payment. The significance of this signatory act and the responsibility associated with it is one of the major government actions, especially on major weapon systems. It is this acceptance act, normally assigned to quality assurance personnel, that in effect closes the procurement cycle loop making the quality assurance role one of prime importance in the procurement process.

E. DISCUSSION OF QUALITY AND RELIABILITY POLICIES AND PRACTICES

From a quality standpoint, there is no recognizable positive motivational policy. There is a penalty-type motivation in the sense that if a DD 250 is not signed, cash flow to the contractor will be at least

interrupted. There is the same consideration inherent in the government in-plant quality assurance program in that penalties can be assessed formally or informally by varying the quality assurance approach to inspection. There are some positive aspects such as permitting reduced sampling, or the CAP concept, or the references to quality vs. profit in the DAR. In general, however, there is no recognizable and significant positive motivational approaches or initiatives in the quality assurance program. Neither the negative or the positive features of quality policy are organized into any centralized approach.

Reliability policy has emphasized the necessity for specifying measurable reliability requirements. In conjunction with this, there has been innovative contracting approaches developed such as Life Cycle Costs, Reliability Improvement Warranty, etc. These are essentially profit-based motivational concepts and generally relate to DAR approaches such as the performance incentive and can either increase or decrease profits depending upon performance. As in the case of product quality policy, product reliability policy is not organized into any centralized cohesive approach.

From a broad procurement policy standpoint, there is at least a theoretical basis for motivating contractors by relating profits to performance. There are opportunities to relate product quality to such areas as source selection. There are contracting approaches such as the CPAF or performance incentive techniques where there are opportunities to use the profit motive.

There is no visible motivational aspects of policy anywhere that directly relates to the operator class of contractor personnel for either product quality or product reliability. There is no significant language in policy that encourages contractors to initiate motivational programs.

TABLE II-1

PRODUCT QUALITY RELATED CLAUSES

Clause	Supply Contract		R&D Contract	
	Fixed Price	Cost Reimburs.	Fixed Price	Cost Reimburs.
Inspection	7-103.5		7-302.4	
Title and Risk of Loss	7-103.6	7-205.3	7-302.28	7-404.7
Payments	7-103.7		7-302.2	
Responsibility for Inspection	7-103.24			
Rights in Data and Computer Software	7-104.9	7-204.9	7-303.54	7-403.49
Government Property	7-104.24	7-203.21	7-303.7	7-402.25
Quality Program	7-104.28	7-204.10	7-303.15	7-403.15
Inspection System	7-104.33			
Progress Payments	7-104.35		7-303.23	
Value Engineering	7-104.44	7-204.32	7-303.31	7-403.27
New Material	7-104.48			7-403.30
Production Progress Report	7-104.51	7-204.47		
First Article Approval	7-104.55	7-204.39	7-303.39	7-403.34

Table II-1 (Cont'd)

PRODUCT QUALITY RELATED CLAUSES

Clause	Supply Contract		R&D Contract	
	Fixed Price	Cost Reimburs.	Fixed Price	Cost Reimburs.
Material Inspection and Receiving Report	7-104.62	7-204.44	7-303.13	7-403.41
Preservation Packing and Packing Requirements	7-104.67			
Marking of Shipments	7-104.68			
Safety Precautions for Ammunition and Explosives	7-104.79	7-204.49	7-303.20	7-403.24
Aircraft, Missile and Space Vehicle Accident Reporting and Investigation	7-104.81	7-204.36	7-303.48	7-403.45
Engineering Change Proposals	7-104.89	7-204.56	7-303.58	7-403.53
Liquidated Damages	7-105.5		7-304.7	
Warranties	7-105.7		7-304.10	
Inspection of Supplies and Correction of Defects		7-203.5		7-402.5
Order of Precedence		7-204.40	7-303.40	7-403.35
Standards of Work			7-302.3	7-402.4
Make or Buy Program		7-204.20		7-403.14

III. QUALITY AND RELIABILITY MOTIVATING FACTORS

III. QUALITY AND RELIABILITY MOTIVATING FACTORS

A. GENERAL

It is an obvious truism that the classic business objective of the industrial firm is to make money. A business, however, is a complex enterprise and on a particular contract, profit is not necessarily the prime objective. Other factors may impact on the profit goals of a firm depending on, for example, the product, the phase of the corporate life cycle, the market structure and other considerations as well.

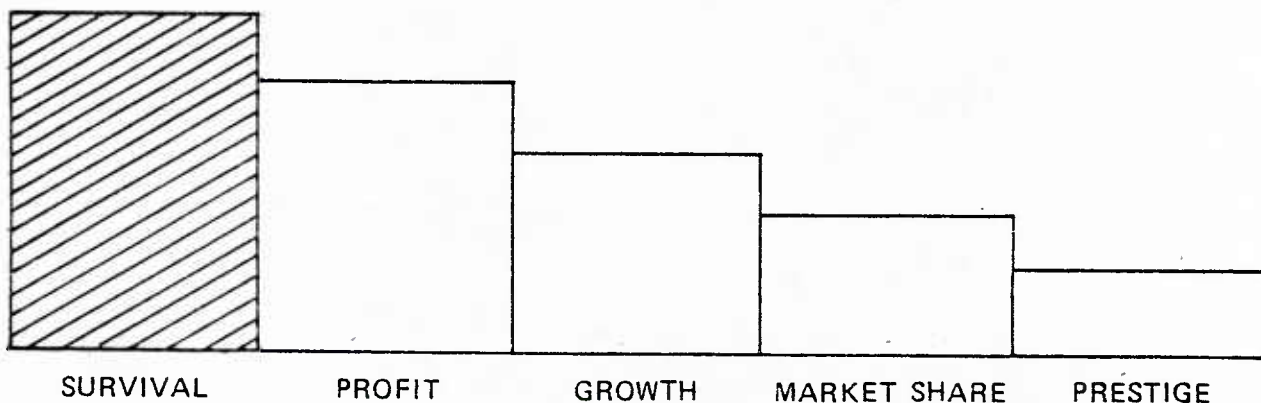
B. MOTIVATION OF THE FIRM

Obviously a firm does not spring into existence as a viable, successful enterprise. Under ordinary circumstances the firm must begin with only a future capability to provide a product or service. As the firm progresses from its beginnings to full operation, its goals and motivations are in a continuous state of change. These motivations of the firm can be considered to be a "need" and a hierarchy of needs for the firm can be developed as Maslow⁹ developed such a hierarchy for individuals. The hierarchy of needs for the firm and the firm's emphasis on them constantly shift as the firm moves through its own unique development cycle. These needs have been identified as survival, profit, growth in market share and prestige.¹⁰

While survival is a primary concern of all firms, it is the primary, and initially, the only need of the emerging firm. All other needs become secondary until the survival stage is safely completed. The corporate hierarchy of goals can be illustrated as in Figure III-1 below until survival is assured.

Figure III-1

Corporate Hierarchy of Goals: Survival Phase



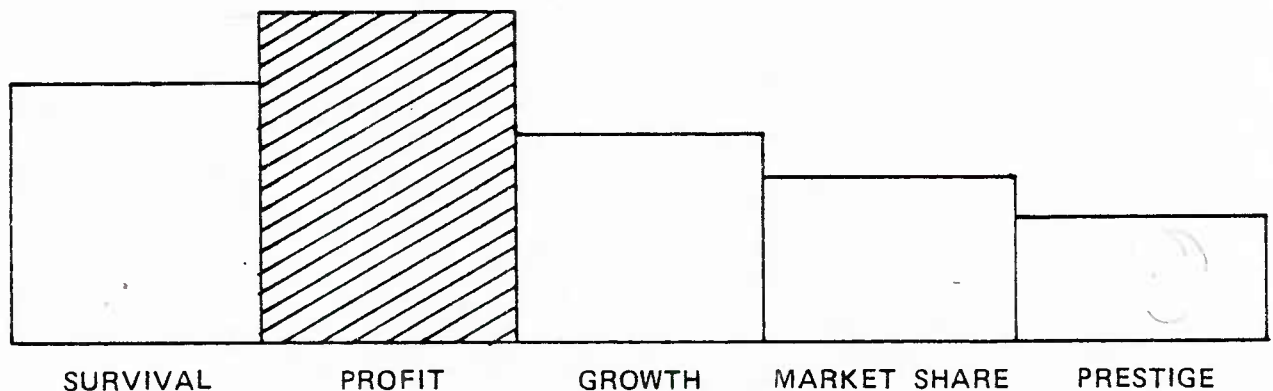
⁹ Maslow, A. H., Motivation and Personality, Harpers & Bros., New York, 1954

¹⁰ Oppedahl, Phillip E., Understanding Contractor Motivation and Contract Incentives, Defense Systems Management College 1977

Once survival is assured it then becomes necessary to consolidate the firm's position in the market and its continuing existence by returning a profit above and beyond the income necessary for salaries, machinery, real estate, etc. In the hierarchy of corporate goals then, with survival assured, the firm's motivations, or needs, may be depicted as in Figure III-2 with profit as the primary goal or need.

Figure III-2

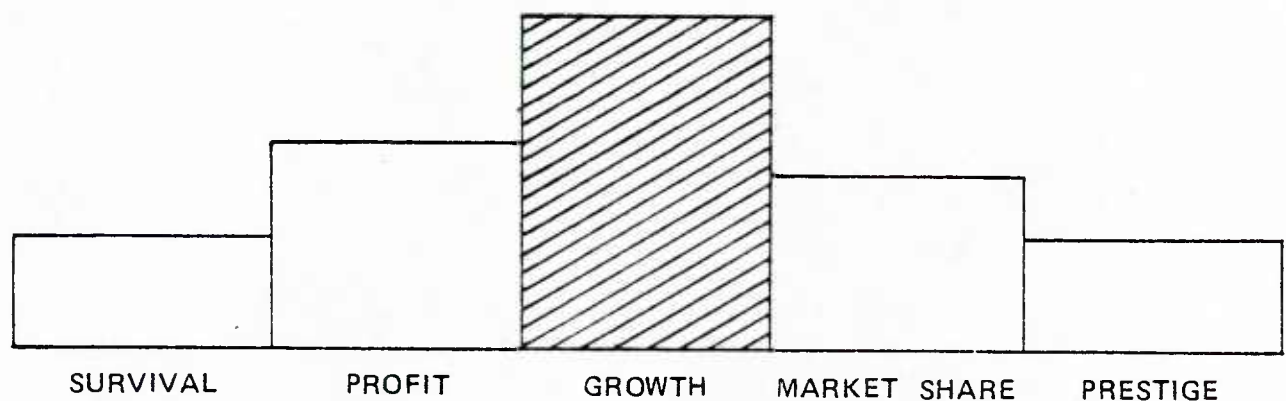
Corporate Hierarchy of Goals: Profit Phase



Profit does not resolve itself into a simple goal to maximize due to several other issues. Profit is an elusive term and goes beyond simply earnings per share (EPS). EPS is an end product resulting from a array of actions that are subject to wide fluctuations which may result from management decisions, increases or decreases in such expenditures as R & D, advertising, employee training programs and other discretionary outlays. However, at some point in time, the firm's management process will result in a decision that profit is adequate or normal for its industry, and that the firm's growth should now become the overriding objective. At this time, the hierarchy of needs of the firm will appear as in Figure III-3.

Figure III-3

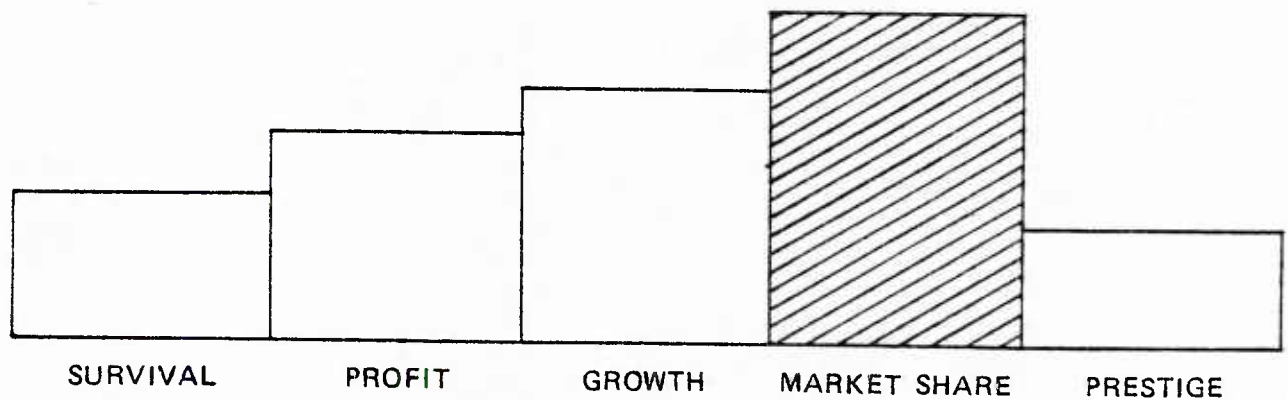
Corporate Hierarchy of Goals: Growth Phase



As the corporate goal shifts in the direction of increasing growth, the central thrust will be growth in sales since increasing sales results in growth in the firm's competence and capabilities. As the individual contracts become larger or more numerous, there is an increasing capability to improve equipment facilities and manpower strength. Thus, consideration may be given to improving a relative position in the market place and the overriding motive becomes that of increasing the company's market share as shown in Figure III-4.

Figure III-4

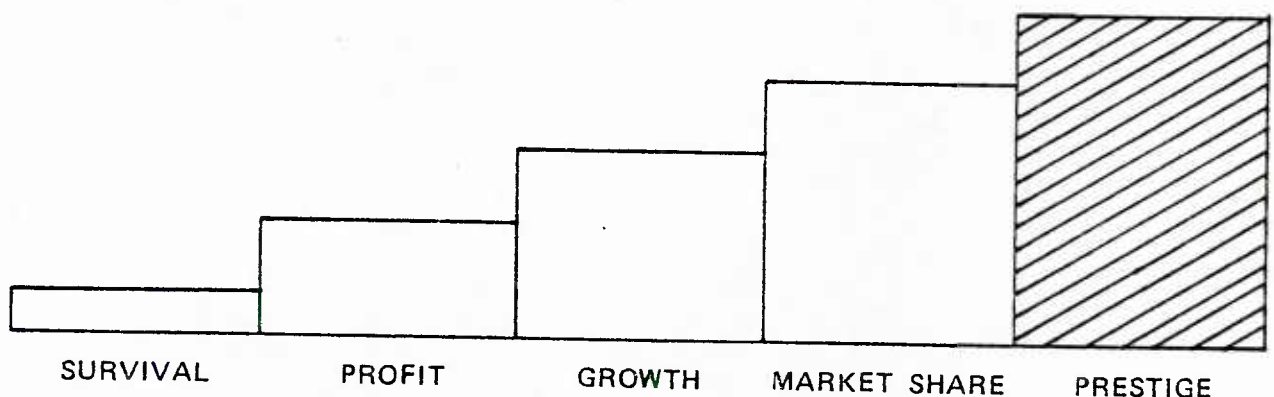
Corporate Hierarchy of Goals: Market Share Phase



At the time the firm becomes a major force in its own market there is little more to be gained unless a monopoly is to be achieved. The major automobile manufacturers are classic examples; it is not enough to be one of the largest firms in the nation with a major share of the market. What then remains is to gain prestige supremacy or to become number 1. When this is achieved the firm's goals in order of dominance will be as depicted in Figure III-5.

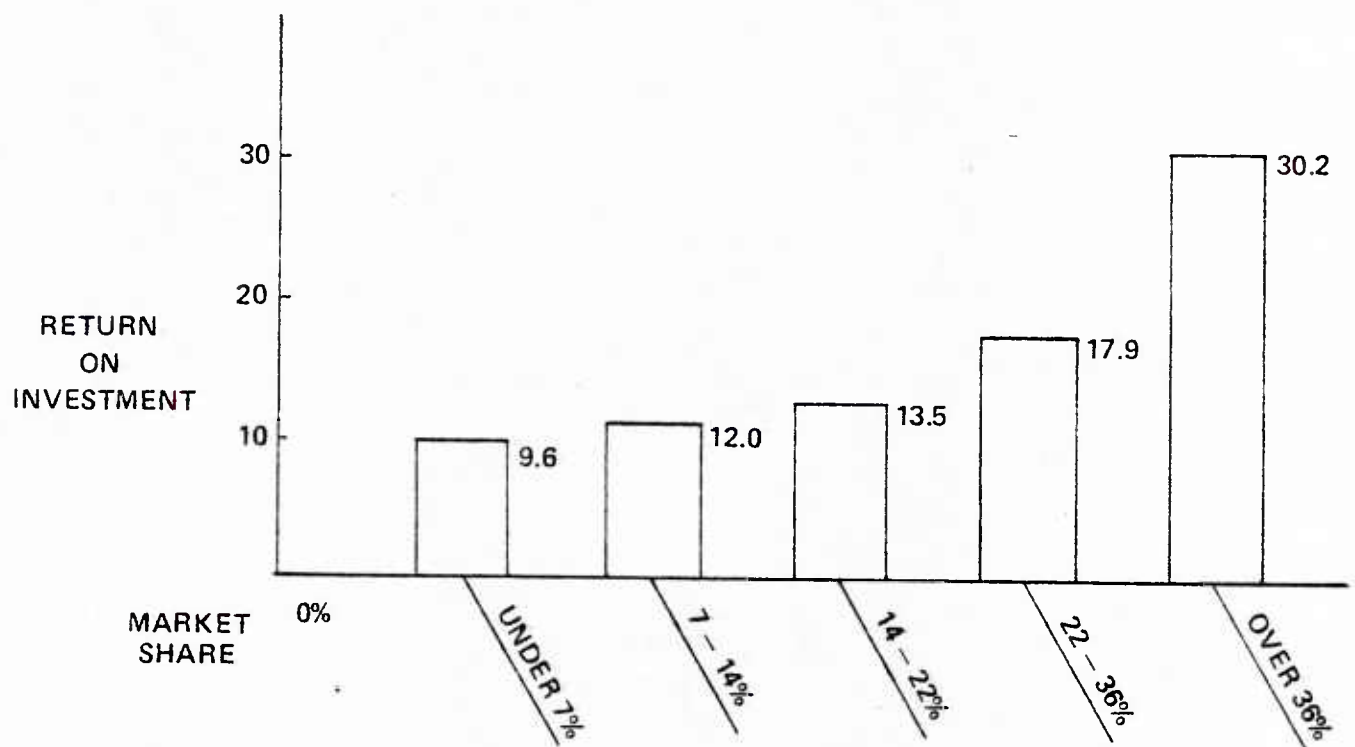
Figure III-5

Corporate Hierarchy of Goals: Prestige Phase



Quality and profit and share of the market all bear a relationship to the life cycle phase of the firm. It has been shown that, on the average, Return on Investment (ROI) goes up with increases in the market share.¹¹ Those firms with market shares above 36% earned more than three times as much relative to investment as businesses with less than 7% share of their market. This relationship is illustrated in Figure III-6.

Figure III-6
Return on Investment as a Function



Insofar as quality is concerned, the same investigation found the relationship between share of business and product quality to be as shown in Table III-1 below:

¹¹ Schoeffler, Sidney, Robert D. Buzzell and Donald F. Heany, Impact of Strategic Planning on Profit Performance, Harvard Business Review, (March-April), Boston, 1974

Table III-1

Quality As a Function of Market Share

<u>% of Business With Products Of:</u>	<u>Market Share Under 12%</u>	<u>12-26%</u>	<u>Over 26%</u>
Inferior Quality	47%	33%	20%
Average Quality	30%	36%	30%
Superior Quality	23%	31%	50%

These statistics confirm that market share is an important motivational consideration that has a definite relationship to product quality. They also confirm that increasing the market share may very well be a part of the firm's overall strategy and, in turn, result in an improvement in quality. The determinations on any individual contract may well be concerned with factors that go beyond the immediate profit tactic. The need to grow before market share can be increased is obvious and the benefits to be gained by increasing market share are also clear. Profit on any individual contract can become a secondary objective.

C. MOTIVATION OF CONTRACTOR PERSONNEL

The Defense Department procurement budget for fiscal year 1980 is over 35 billion dollars.¹² The size of this market by itself is massive enough to motivate contractors to wish to enter it. Studies of the characteristics of business firms over the years has shown that there are numerous motivations that are assignable to the objectives of the firm. There are, as well, other interacting personal motivations that, while usually supportive, may be divergent from the firm's goals or needs.

Some contractor personnel view profits as an abstract issue and contract performance as a real issue while another category sees contract performance as an abstract issue and profits as the real issue. The term "contractor" in the DAR relates closely to an abstract view of profit although it is primarily concerned with achievement of performance objectives. In order to gain an overall perspective of all of the motivations, contractor personnel are divided into corporate management, upper middle management, project managers, and operators as follows.

1. Corporate Management

Corporate management is defined primarily as those individuals who must interact between the owners of the firm and those personnel who are actively involved in the day-to-day management process. In some cases, the same personnel fulfill both roles, especially in small firms. In larger firms, these management officials have another role other than that of acting as a link between stockholders and operators, and that is their responsibility for the broader social responsibilities. This role of social responsibility

¹² Department of Defense Annual Report, Fiscal Year 1980

is best fulfilled by assuring the continuing vitality of the firm which in turn provides profits, keeps employment levels up, fulfills responsibility to creditors and affects stability in those geographical areas where company personnel are situated.

Corporate management's personnel concerns consist of a complex bundle of human needs such as self-actualization, esteem and power. They also have strong economic drives coupled with the psychological benefits resulting from personal/corporate achievements. A national survey of executive compensation has shown that bonuses for the three top executives of major corporations are closely tied to the previous year's earnings.¹³

At this level of management the question of meeting or exceeding reliability and quality (R&Q) requirements would not seem to be a major consideration. These officials will most likely be much more concerned with factors such as return on investment or earnings per share. A further list, although probably of somewhat less consequence would include market share, R&D expenditures, marketing expenditures and investment intensity, i.e., ratio of total investment on sales.

In short, corporate owners primary interests are generally centered around profit factors and since corporate officials usually serve at the pleasure of owners, profit becomes their major concern. Other factors, some of which are discussed above, are also of prime importance. The question of reliability and quality, particularly for a firm devoted to military sales, is not likely to be a subject of prime interest at the corporate level.

2. Upper Middle Management

The upper middle level of management includes typically, division managers, profit center managers and other senior officials who, while not upper corporate officials, are influential in the formulation of policy and operational procedures and are concerned with customer satisfaction and associated profits. They have, however, numerous other concerns which must be balanced against profits.

These managers are defined as those upper level managers who, while they are concerned with implementing the highest corporate policy, are in a management mode in which they make significant operational decisions. This group of managers, depending on the size of the company and the government program, may deal directly with company program managers or may have less senior officials interfacing between them and the program manager.

These managers may be assumed to reflect a mixture of needs of the corporation and needs of the individual. Corporate hierarchial needs described earlier were identified as survival, profit, growth, market share and prestige,

¹³ Rappaport, Alfred, Executive Incentives vs. Corporate Growth, Harvard Business Review (July-August) Boston, 1978

in that order. Clearly survival would be the most basic of the need hierarchy. However, once satisfied, the other needs will change in rank of importance as newly emerging needs of the organization are met to varying degrees. Maslow, as is well known, developed a hierarchy of needs (modified by McGregor),¹⁴ for individuals which in the case of the middle manager also represent important factors. These needs may be translated roughly into survival (subsistence earnings), continuing employment, social or group acceptance, ego and self-fulfillment. While the middle manager teeters on the balance between the needs of the firm and his own humanistic needs and attempts to satisfy both those senior officials above and junior officials and employees below, he can identify with more force and clarity corporate management concerns.

3. Project Managers

For the purposes of this investigation, the other key influential source of managerial impact is considered to be the project manager. It is recognized there may be supervisory levels between this individual and middle level management and there are certainly supervisory personnel who are junior. We will consider these more junior managers in other parts of the study. However, they have a much smaller impact on the significant elements of the management process. The project manager has a more singular and insulated view of what he is expected to achieve in terms of equipment performance. His personal perceptions of success are closely related to direct job success, i.e., equipment produced on schedule within cost, meeting all requirements. The project manager's goals are what might be termed instant goals, that is, success in meeting the goals is immediately demonstrable as opposed to long-term corporate goals such as increasing market share or waiting to see if an R&D expansion will become a profitable venture, or waiting years for a long-term incentive to be paid.

4. Operators

Operators are defined as those individuals who do not have a supervisory role. They are normally thought of as blue collar or hourly employees. For this discussion, however, all non-supervisory personnel are within this definition including design engineers, test operators, reliability engineers, inspectors, machinists, etc. They are included because they have a major influence on how well equipment will operate, on its durability, as well as simply getting through the in-plant inspection/test process.

This group of employees have limited or in many cases no contact with the management personnel described earlier. Their rewards and remuneration are usually established by either personnel policies or by union negotiations with management or both. Except for a very small group in the operator class, they have limited knowledge of how well the system they are working on is performing. Generally, their rewards bear no relationship to its success other than they do or do not have a job.

This category of contract personnel have been subject to much study and examination, in particular, the blue collar subgroup. In the weapon system industry, however, many personnel with engineering degrees work in what approaches assembly line conditions. The hundreds of engineers at desks or drafting tables in a large, busy, weapon systems contractor's plant illustrates this situation.

¹⁴ McGregor, D., The Human Side of Enterprise, McGraw Hill, New York 1960

The needs and motivation of these individuals have been examined by such authorities as Frederick W. Taylor, Frederick Herzberg, Douglas McGregor, A. H. Maslow and others and there is little to be gained restudying the motivational factors that can influence their input on quality of product. It is worthwhile, however, to identify them, in no particular rank or order, as safety, membership, self-esteem, status/prestige and self-actualization. It is also notable that the worker has been held to be accountable for 20 percent of the product defects.¹⁵ The costs associated with this proportion of defects is certainly a problem worthy of attention.

The DAR has taken the approach that profit is the prime motivating factor and has designed several contracts for various situations, e.g., R&D, production, which allows profit to vary depending on contractor performance or risk. Past performance is considered to include product performance and delivery as a profit consideration and is considered in the source selection process. Performance has been deleted, however, as a consideration in determining profit factors under cost reimbursement contracts.¹⁶ There is no consideration in the DAR to motivation of any particular segment of personnel in the firm, however, it appears that profits do go to corporate and upper management personnel in the form of bonuses, etc. No consideration or guidance is given in the DAR which relates to personnel such as operators and their needs as described by Maslow and others.

D. PROFIT AS A MOTIVATOR

The presumption of profit as the basic motive of industry is undoubtedly true in the general sense since in the open market the firm will not survive without profit. For the DoD, however, it may be an overly simplistic approach and one that is flawed since it is (1) based on a questionable assumption of operating in an open market, and (2) while it is a general assumption, it is applied on a contract by contract basis. In other words, it is a general assumption applied to an instant contract situation.

The Logistics Management Institute reported that, "There is virtually unanimous agreement among managers and analysts who have studied overall contractor motivation that, in the short run, contractor management does sacrifice short-run profit on defense business in favor of achieving:

- o company growth
- o increased share of the industry market
- o better public image
- o organizational prestige
- o carry-over benefits to commercial business (commercial spin-offs)
- o greater opportunity for follow-on business, or
- o greater shareholder expectations for future growth and profit.

¹⁵ Juran, J. M., Quality Control Handbook, Third Edition, McGraw Hill, New York, 1974

¹⁶ Defense Procurement Circular 76-3, September 1976

Profit sacrifices are made in the process of acquiring a contract as well as in the process of executing it. While there is a practical limit on the extent to which current profit can be sacrificed, that limit rarely causes short-range profit to dominate management decision making.¹⁷

Another view of the reasons firms enter the defense market was presented by Professors Hunt, Rubin and Perry, who after surveying 27 industrial organizations found that despite the constant stressing of profit motivation by government personnel, contractor personnel saw the government market as the only one in which they could satisfy their desire to be involved in high technology fields.¹⁸ In the survey the following reasons were cited for entering the government market, in descending order of importance:

<u>Reasons for Entering the Government Market</u>	<u>Percentage of Respondents Citing Reason</u>
The government market was the only market or the only sizable market for the product the organization wanted to sell	26%
The government is, if not the only market, a large market affording high volume sales	24%
The government market offers a chance to develop personnel (both managerial and technical) and/or potential commercial products	22%
Natural interest with involvement in technological fields	20%
That the government is a low risk market (implying either that it is safe or that it is a low investment market)	17%
That it affords opportunities for profit	14%
Patriotic duty	10%
That it affords a chance for market diversity	7%
Glamour or opportunities for image building	6%

Insofar as product quality is concerned, the appended INTEC survey showed profit in the form of performance incentive or award fee, to rank well below the quality related, contractually required programs, e.g., quality, reliability as a quality motivator. The findings of the investigators cited, and others not referenced were supported by the INTEC survey in which 82

¹⁷ Logistic Management Institute, An Examination of the Foundations of Incentive Contracting, Washington, D.C., May 1968

¹⁸ Hunt, Rubin and Perry, Federal Procurement: A Study of Some Pertinent Properties, Policies and Practices of a Group of Business Organizations, State University of New York at Buffalo, March 1969. Percentages cited do not add to 100% because of multiple responses.

respondents answered how they would rank the impact of various contractual devices as far as the quality of material was concerned. In line with other findings, profit ranked well down in its impact as compared to reliability demonstrations or quality and reliability programs. Profit in this context was discussed in terms of cost plus award fee or performance incentive type of contracts.

As a general observation, profitability is not a compelling element of government business in general when compared to commercial business. The Profit 76 study showed an average of 14.8% profit before taxes for commercial business compared to 5.6% for government business. Figure III-7 illustrates the Profit 76 findings.

The findings of other researchers that profit is not the foremost factor is supported by the findings of the INTEC investigation as well. While profit, of necessity, must be a consideration, its motivational power varies depending upon the peculiar position of the firm in its own hierarchy of needs and it cannot be considered a dominant factor on each contract. Stated again, the overall necessity for business to make a profit is not necessarily valid for each contract issued by the DoD.

E. CONTRACTOR MOTIVATION VS. CONTRACTING TECHNIQUES

In the interview and questionnaire process conducted as part of this study, numerous questions were asked that generally related motivation in contractual terms to product quality. The complete questionnaire results are found in Appendix A of this report. However, selected findings are reviewed in the following paragraphs in connection with contractor reaction to motivations that correspond to DoD contracting motivational aspects both positive and negative.

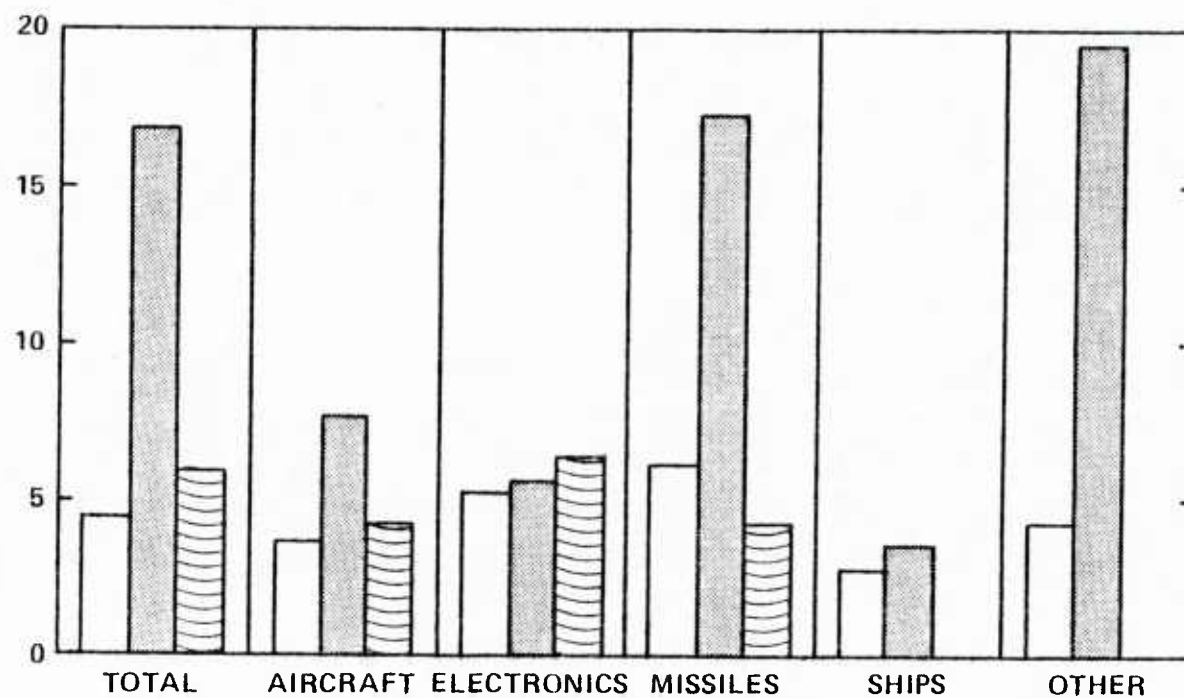
1. Direct Profit and Quality




Figure III-8 relates the conclusion drawn from 82 firms who were asked by INTEC to rank the DAR clauses on contracting approaches in terms of their impact on quality. The respondents were given the option to rank them as: (1) negative impact, (2) no impact, (3) slightly beneficial, and (4) very beneficial. A weighted analysis resulted in ranking them in the relative orders shown in the figure.

It can be seen that management systems, e.g., Quality Program, Reliability Program, and Maintainability Program were seen as having a more positive effect on product quality than were those clauses that are considered to be motivational in nature. It can also be seen that the penalty-oriented or negative motivational clauses such as liquidated damages have little benefit as well. As far as product quality and motivational contracting approaches are concerned, this data shows that the customary management programs are perceived by the respondents as more effective than either positive or negative motivational approaches.

Figure III-7
 PROFITABILITY — RETURN ON SALES
 PROFIT BEFORE TAXES/SALES
 5 YEAR AVERAGE BY PRODUCT GROUP

PBT/SALES %



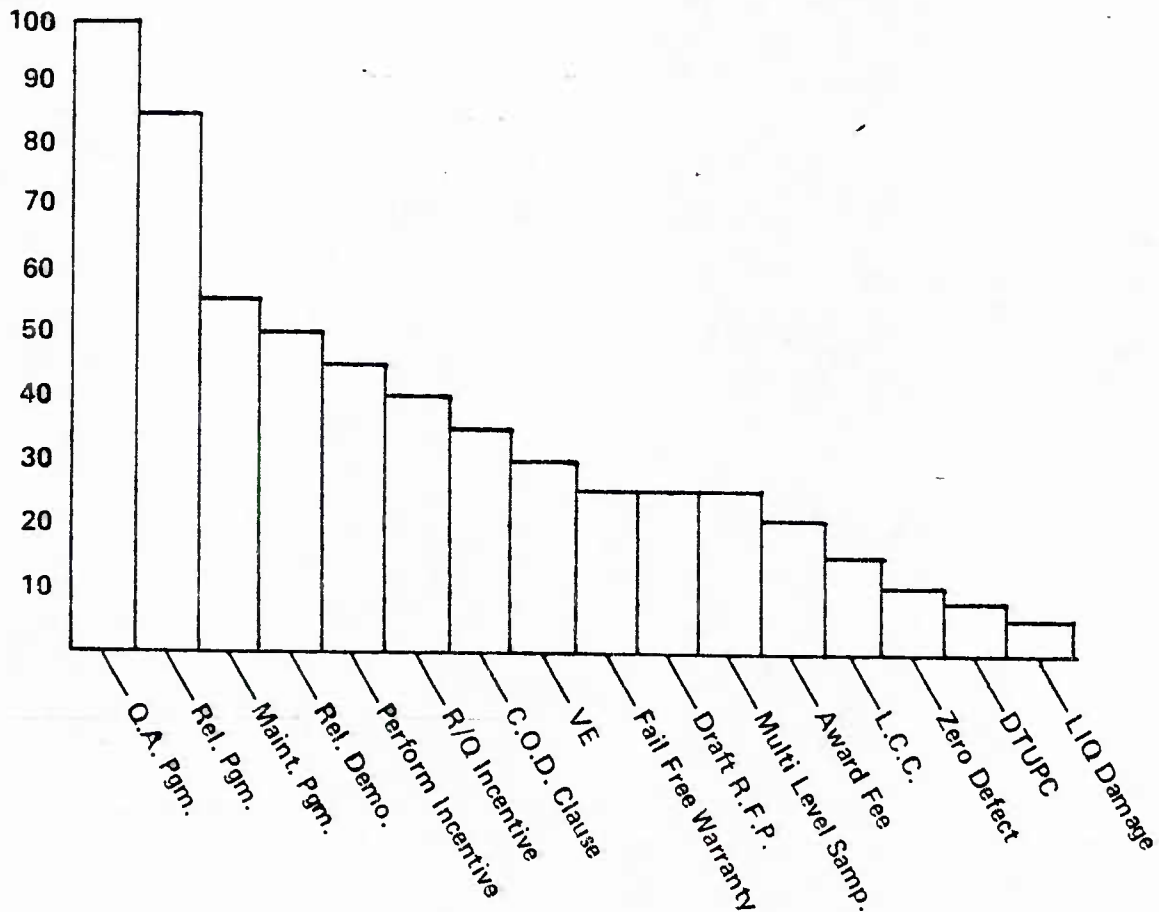
GOVERNMENT BUSINESS 
 COMMERCIAL BUSINESS 
 FTC DURABLE GOODS 

4.7	3.7	5.4	6.1	* 2.9 (.6)	4.5
17.1	7.5	5.8	17.7	3.5	19.3
6.7	4.2	6.3	4.2	—	—

* 2.9 - Includes full amount of claims outstanding
 (.6) - Assumes settlement of claims at historic value

Figure III-8

Contractor Ranking of DAR Clauses in Terms of Impact on Quality



When the respondents were asked to rate financial incentives, e.g., profit, as a management tactic to assure suppliers provided material of the requisite quality they responded as follows:

<u>No Benefit</u>	<u>Slight Benefit</u>	<u>Significant Benefit</u>	<u>Best Method</u>	<u>No Response</u>
17%	46%	27%	4%	6%

When asked the same question about psychological incentives, the response was:

<u>No Benefit</u>	<u>Slight Benefit</u>	<u>Significant Benefit</u>	<u>Best Method</u>	<u>No Response</u>
23%	48%	16%	1%	1%

When asked to rank low profit as a problem resulting in the production of non-conforming material, the answers were:

<u>No Problem</u>	<u>Slight Problem</u>	<u>Significant Problem</u>	<u>Serious Problem</u>	<u>No Response</u>
39%	34%	18%	2%	7%

In order to equate low profit as a factor, respondents were also asked to rank poor specification of requirements in the same way. The response was:

<u>No Problem</u>	<u>Slight Problem</u>	<u>Significant Problem</u>	<u>Serious Problem</u>	<u>No Response</u>
4%	8%	43%	43%	2%

During the course of interviews with government personnel, it was suggested that contracts of longer duration would be desirable to motivate employees to high quality workmanship. That question was responded to as follows:

<u>No Benefit</u>	<u>Slight Benefit</u>	<u>Significant Benefit</u>	<u>Best Method</u>	<u>No Response</u>
17%	29%	28%	7%	19%

When special bonuses or cash awards were considered, the answers were:

<u>No Benefit</u>	<u>Slight Benefit</u>	<u>Significant Benefit</u>	<u>Best Method</u>	<u>No Response</u>
12%	35%	37%	10%	6%

When increased pay was considered the response was:

<u>No Benefit</u>	<u>Slight Benefit</u>	<u>Significant Benefit</u>	<u>Best Method</u>	<u>No Response</u>
15%	50%	25%	4%	6%

Fiscal related rewards were equated to psychological incentives. Official recognition was considered, the answers were:

<u>No Benefit</u>	<u>Slight Benefit</u>	<u>Significant Benefit</u>	<u>Best Method</u>	<u>No Response</u>
0%	4%	54%	39%	3%

The results of the above survey indicates that, in terms of product quality, profit for the firm and increased financial rewards for employees are not particularly effective motivators. In the same vein, penalty oriented contractual clauses are shown also to have little effect on product quality.

2. Incentivised Profit vs. Quality

The DAR contains quality associated options/clauses/approaches that can be considered motivational in terms of additional income by incorporation of incentive fees for varying levels of performance. These can be added to anticipated profit or sometimes deducted from it as a consequence of achieving, not achieving or surpassing performance goals.

Respondents to the INTEC questionnaire were asked if they had experience with selected incentive type approaches, what they would expect the impact to be on quality when they were included in a contract. The methods cited were Life Cycle Cost, Failure-Free Warranty, Multi-Level Acceptance Sampling Plans, Performance Incentive, and Cost Plus Award Fee (CPAF). The responses were as follows:

	<u>Negative Impact</u>	<u>No Impact</u>	<u>Slightly Beneficial</u>	<u>Very Beneficial</u>	<u>No Experience</u>
Life Cycle Cost	0%	12%	26%	12%	50%
Failure-Free Warranty	0%	12%	11%	18%	59%
Multi-Level Accep- tance Sampling Plan	2%	17%	28%	13%	40%
Performance Incentives	2%	10%	17%	32%	39%
CPAF	0%	11%	18%	16%	55%

The above data indicates that there is some benefit to be derived in relation to product quality by using this group of clauses, all of which can directly or indirectly lead to increasing, and in some cases decreasing, profit margins. The data also gives some insight into the usage of the profit related approaches. No response was interpreted as no experience.

There are no "pure" motivational approaches in the DAR that do not relate to profit in some form. However, two motivational techniques that have been used, or at least encouraged in contracting methodology are Zero Defects and the Draft Request for Proposal. The same question regarding these methods impact on quality was asked and the responses were as follows:

	<u>Negative Impact</u>	<u>No Impact</u>	<u>Slightly Beneficial</u>	<u>Very Beneficial</u>	<u>No Experience</u>
Zero Defects	4%	18%	23%	11%	44%
Draft RFP	1%	12%	21%	15%	51%

It is clear that many of those respondents that have utilized these methods have found them beneficial and equally clear that they are not extensively used.

The intent of penalty clauses presumably is to encourage firms to produce material of the requisite quality. Accordingly, respondents were asked about the impact on quality when the liquidated damages clause is employed. The answers were:

	<u>Negative Impact</u>	<u>No Impact</u>	<u>Slightly Beneficial</u>	<u>Very Beneficial</u>	<u>No Experience</u>
Liquidated Damages	6%	24%	9%	0%	61%

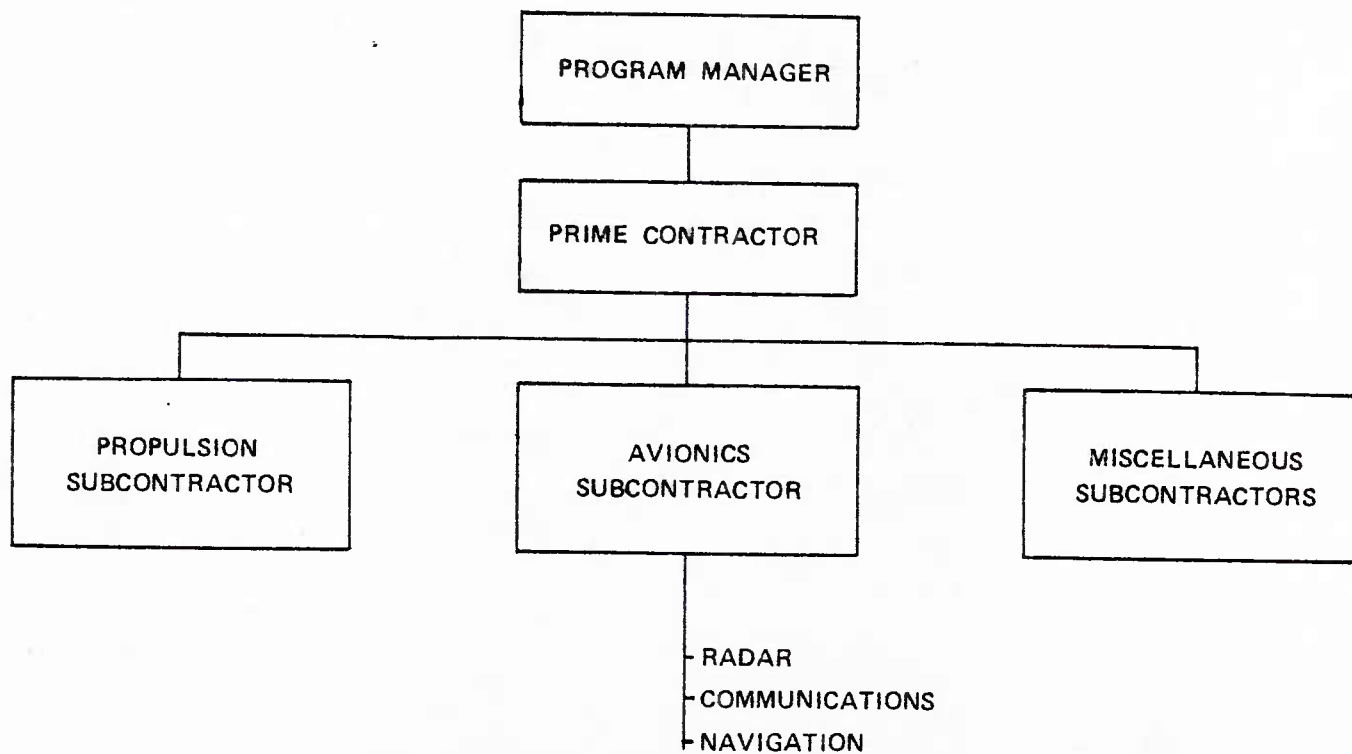
F. CONTRACTUAL MODES AND CONTRACTOR MOTIVATIONS

In considering motivation in terms of Air Force equipment products, it may be useful to examine the system procurement process and review how equipment performance goals are established and how firms respond to the contractual mode. For this example, an aircraft case will be utilized.

In the system procurement process, the USAF has available considerable latitude in deciding how to interface with the multiplicity of contractors that will necessarily be involved. Once the contracting office has made a firm decision as to what configuration of product will be bought and selected the prime contractor, there are still numerous secondary level decisions that are necessary. For example, shall equipment to be integrated into the prime system be selected by the purchasing office and be provided by associate contractors and therefore be Government Funded Equipment (GFE), or shall it be selected by the prime, or integrating contractor and provided by subcontractors. It is obvious that contractor incentives and motivational considerations are affected by such decisions. Figures III-9, 10 and 11 illustrate some of the possible contracting modes. The prime weapon system in the example is that of aircraft.

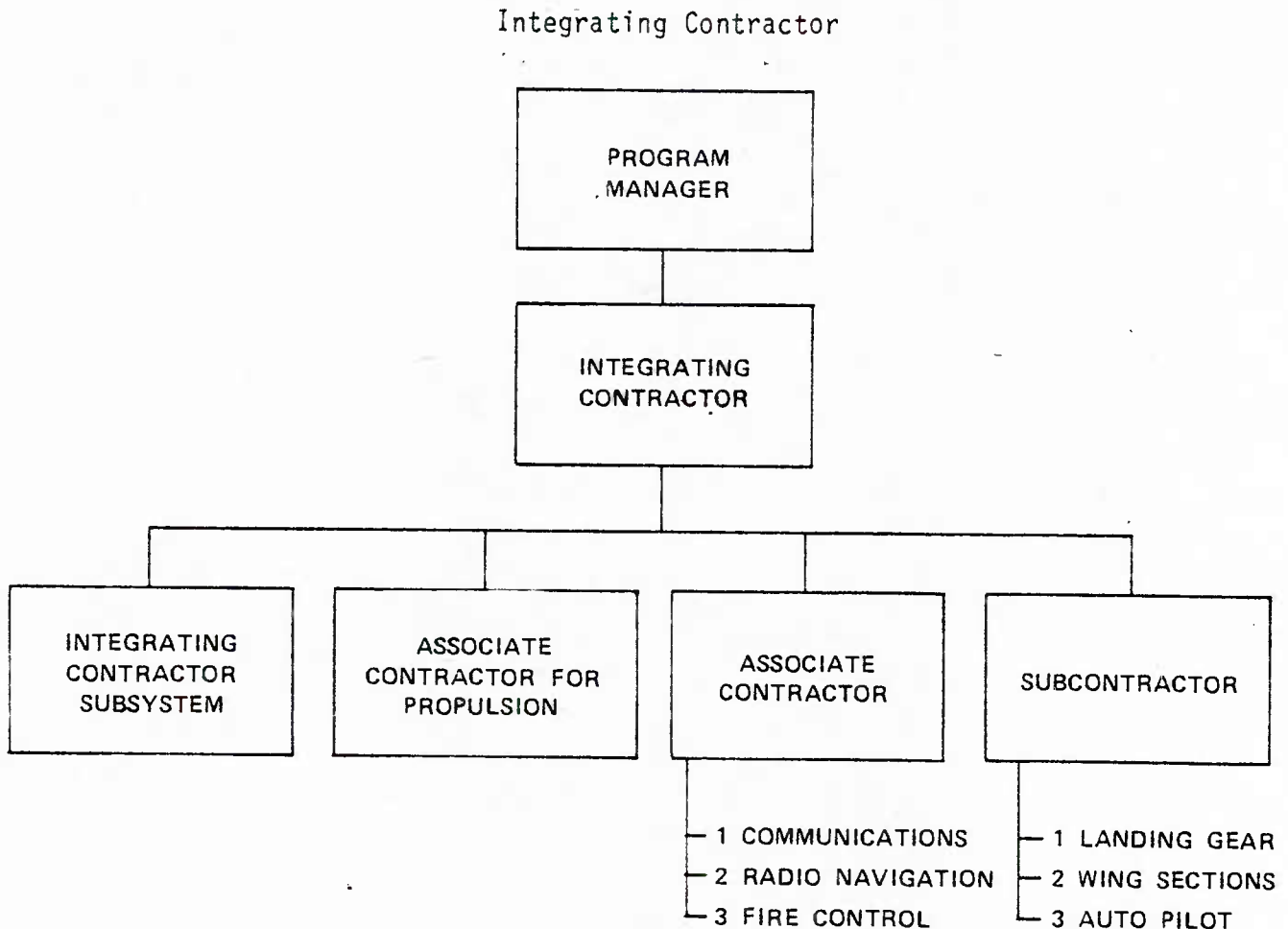
Figure III-9

Single Prime Contractor



In Case #1, Figure III-9, the prime contractor has an obvious need to assure that his subcontractors (all suppliers) are successful and that he is successful in making their equipment perform, interface, and operate successfully within his airframe subsystem. Subcontractors also have greater pressure to perform against the threat of being eliminated as a supplier.

Figure III-10

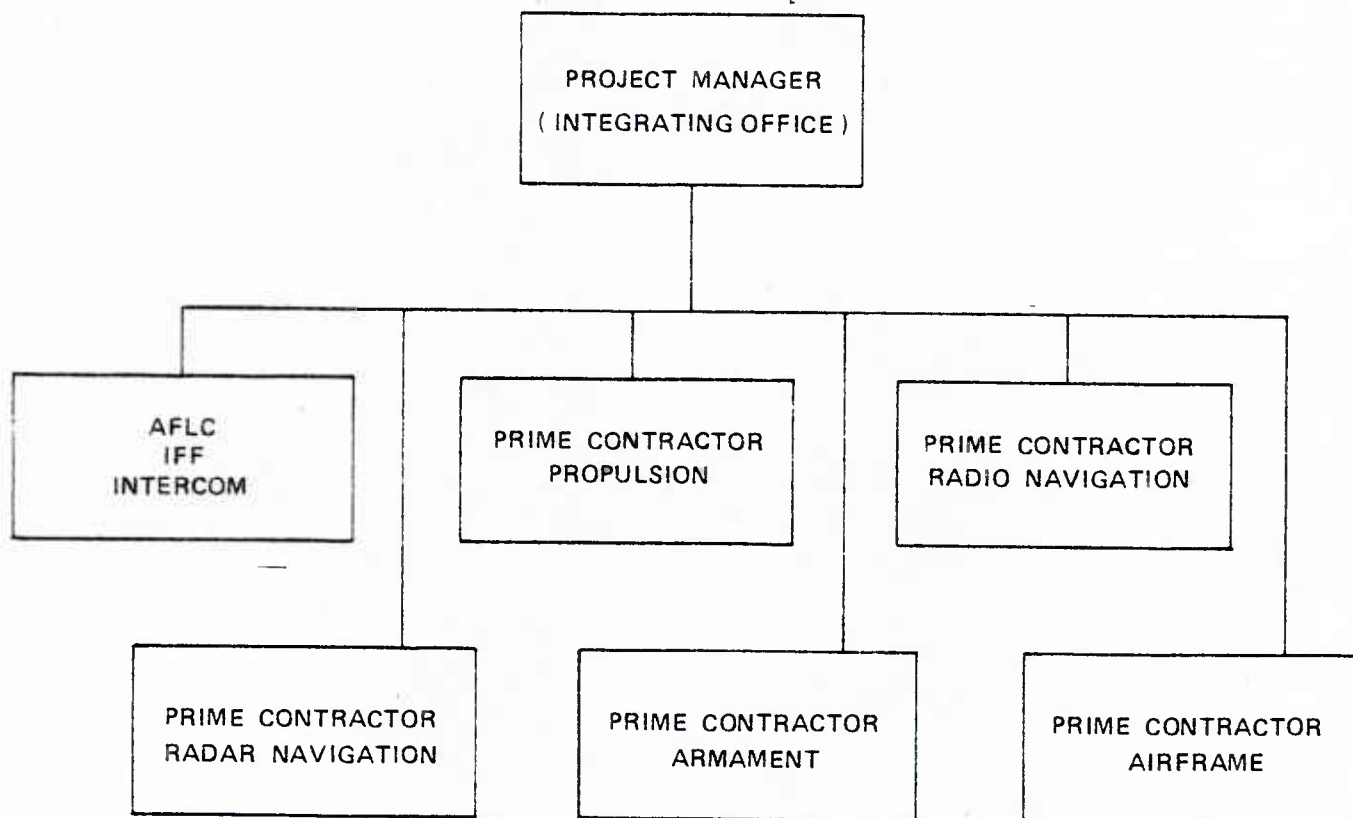


In Case #2, Figure III-10, the integrating contractor is typically an aircraft manufacturer who normally builds the airframe and provides some or all of the subsystems and integrates them into the airframe. In this example, the integrating contractor's desire to make all of the subsystems perform together will be altered by the fact that the government selected some of the subsystems. Thus, the lines of responsibility begin to blur between the systems selected by the government and those selected by the contractor. The contractor now cannot be expected to assume responsibility for Government furnished property's performance and must be reimbursed if it can be demonstrated that a fault in Government provided equipment requires extra

effort to make it function successfully. The responsibilities of associate contractors selected by the government are complex and careful government management is in order. There is more opportunity to escape penalty for non-performance since lines of responsibility become increasingly blurred between the associate contractor, their contracting officer and the integrating contractor.

Figure III-11

Direct Project Management Control



Case #3, Figure III-11, need not be explored, however, since it can be seen that it simply compounds the problems of Case #2 and increasingly exposes the program manager to system administration and management problems. The AFLC (or other AF/government supplier) may also exacerbate the problem to an even greater degree due to the additional government interfaces.

Motivations of producers and users, in the sense of prime or integrating contractors, can be seen in the above cases to add to the welter of similar and diverging needs of the significant tiers of management. Added to this are the variations in motivational perceptions of corporate and middle management which are directly affected by the corporate hierarchy of needs.

In a system procurement, the position of the firm on the ladder of corporate needs will result in a differing posture by the corporate and middle management executives in response to problems being encountered.

The conclusions then that can be drawn from the mix of corporate and individual needs impacting on every system procurement are (1) that no one overall government strategy can be applied successfully and uniformly to all contracts without regard to the hierarchial needs posture of the firm at the time of negotiations, and (2) profit should not be assumed to be the primary contractor motivation on every contract.

IV. ANALYSIS OF POLICY AND COMPATIBILITY WITH CONTRACTING MOTIVATIONS

IV. ANALYSIS OF POLICY AND COMPATIBILITY WITH CONTRACTOR MOTIVATIONS

A. OVERVIEW OF QUALITY AND RELIABILITY POLICY

1. Background

Quality policy is an all encompassing term used repeatedly in quality assurance personnel discussions and in the quality related policy. In comparison, reliability policy is a less apparent term. Product quality policy is also less apparent, as most quality policy is organizationally based, particularly in the DoD, i.e., DAR and other DoD directives. By contrast, reliability policy is principally product based with limited organizational related guidance. There is a clear line drawn between quality and reliability functions at all levels.

These two disciplines generally are silent as far as recognition of each other is concerned in their respective directives. Since product quality cannot exclude time related performance characteristics, e.g., reliability, the artificial distinction appears to serve no useful purpose. Within quality assurance organizations, the emphasis on quality assurance organizational matters and contractor administrative programs may have a tendency to overshadow product quality. Another general characteristic of "quality policy" is the loose usage of the term, quality, e.g., quality personnel, contractor quality data, quality requirements, contract quality requirements, quality data, etc. This proliferation of language diffuses and blurs the meaning of quality. There is limited guidance dealing specifically with product quality.

The USAF has traditionally had an appreciation of the complexities of system procurement and has a record of aggressively developing new and innovative methodology intended to increase the yield of acceptable versus unacceptable equipment produced in the manufacturing environment. It is obvious, of course, that the greater the production of acceptable material, the better the cost ratio will become and the more procurement costs will be driven in the direction of minimizing costs.

The litany of techniques used over the years includes product inspection, testing, warranties and numerous other contracting techniques. Traditionally, military procurement methods for assuring the quality of and reliability of material have been an examination before payment, in the form of inspection or test, with a penalty-based system of correction when defective material is found to have been delivered. There is an increasing trend in the direction of reward-oriented warranties which relate extra profits to field performance as in the case of the Reliability Improvement Warranty (RIW). Incentive fees of varying types have gone through intensive cycles of high and low usage and in fact go back to the first airplane bought from the Wright Brothers. Along with the innovative approaches have been strict penalizing contract forms such as the Correction of Defects and Constructive Damage clauses.

The reliability and quality of material delivered to the USAF clearly has an impact on the military readiness of the USAF in terms of mission effectiveness. Reliability and quality of material also have a

direct bearing on procurement demands and supply activities; effect operation and support costs; and even impact transportation requirements and capabilities. Furthermore, during the procurement/production phase of systems acquisitions, procurement costs are affected by scrap, rework, repair and inspection costs. Any costs in these areas cancel expected improvements in supply positions and reduce the availability of procurement funds. Ultimately, defective and unreliable material defers the entry of new systems into an operational posture and reduces the availability of equipment for tactical deployment.

2. Confusion About Quality

Product quality is reviewed by all levels of government managers, ranging from the inspector to the OMB and Congress. Most public discussion of system performance occurs when the system exhibits catastrophic failures in the public view. Since systems that perform well do not receive equal notice, poor system quality is a common public perception.

System acquisition phase quality frequently becomes an issue when Operational Test and Evaluation (OT&E) organizations decide a system should not be fielded, or at least publicize critical test findings. The ensuing disagreements are frequently between the system proponent, the Project Office and the OT&E group, and often require referee decisions. The second area where system quality is frequently disparaged is early in, and sometimes throughout the deployment cycle when logistic support activities find the system is expensive to maintain. In the third case, the operational organizations are not able to perform desired missions.

At the same times these issues arise, the quality assurance organization that accepted the equipment, i.e., signed the DD Form 250, is frequently suspected of not performing their responsibility properly. There has arisen what may be described as the poor quality syndrome, which becomes a vague and illusive but pervasive complaint about "quality" which is dependent upon who is categorizing the system as poor quality and what his particular definition of quality is. The individual's conception of quality leads to frequent questions based on the role and perception of those evaluating quality.

The quality of a weapon system is perceived by the upper levels of military and government management, e.g., Hdqtrs. USAF, Office of the Secretary of Defense and Office of Management and Budget as a function of general operational characteristics of the system.

Using an old, but classic example, Bell Telephone Labs decided to use an existing rocket motor for the NIKE AJAX ground-to-air missile system.¹⁹ This motor used nitric acid and aniline fuel and was selected in place of a ram jet engine which offered potentially greater range and operating economy. The decision was made on the basis that the rocket represented the current state of the art and was known to be feasible, while the ram jet required further research. The ultimate quality of the weapon system

¹⁹ Bell Telephone Laboratories, Inc. Report, AAGM: A Study of an Anti-Aircraft Guided Missile System, July 15, 1945

then was reduced as a result of a technological determination. This demonstrates what may be called quality of design, which relates to what may be termed levels or grades of quality, e.g., JAN grade electronic devices vs. commercial grade.

Personnel who are responsible for determining if material is acceptable in terms of contract requirements will be concerned with assuring that the product under examination conforms in all respects to the established design. Their responsibility is not the quality of design but, instead, with assuring that the product meets all specified requirements. As discussed in other parts of the report, quality has two elements, quality of design and quality of conformance. Design, however, is not normally examined in terms of excellence or in other words, quality.

There are many truisms associated with quality which represent the conventional wisdom and are often expounded; the following are examples:

- o Quality is everyone's business
- o Good quality is essential
- o Good quality means better than ordinary quality
- o Some errors of workmanship are inescapable and excusable
- o The government's job is to specify quality and the contractor's job is to deliver that quality
- o There are levels of quality
- o If you want better quality, increase the contractor's profit

These perceptions cloud the product quality question. Regardless of merit, they do form the basis of many discussions about product quality but it is obvious, most will not provide a reasonable basis for attempting to determine why there are quality complaints.

Assuming that quality assurance personnel are accepting precisely as is specified, then if there are valid complaints about performance or support costs caused by frequent, unexpected failures, they must arise from poor specification of requirements, or a poor design. The function of defining quality of design is performed essentially by middlemen between the inspector and the designer. Quality complaints provided to contract administration organizations usually originate in other functional organizations in which the design function is not recognized as a quality function.

3. Quality Defined

Quality is defined by the Department of Defense (DoD) as "the composite of material attributes, including performance features and characteristics, of a given product or service to satisfy a given need." This definition is

concise compared to the Webster's Dictionary definition which offers several possible variations. In the Webster's definition, however, the term "excellence" does appear. The DoD definition is almost hypothetical in nature and a transition from definition to product is difficult. It is likely that some complaints relate to excellence in the sense of a "deluxe" product with the extra features vs. a standard product. Esthetic features, in terms of attractiveness are usually a by-product in the case of the defense product and not a conscious goal in the contractual sense.

In the contractual sense, quality is defined by a product description in a specification, catalog number or other definition. The definition is specific and does not permit any characteristic other than those defined. There are no variations permitted. The firm is expected to deliver exactly what was requested. There is often confusion introduced by the contractual inclusion of sampling plans in a permissive sense. The contractor may sample and the government will take a chance on unknowingly accepting non-conforming material. However, no non-conforming material is permitted to be knowingly accepted. In other words, the DoD procurement method may be defined as a "zero defect" but not a "zero risk" system.

Specificity of quality definition is at best difficult, other than to say the quality requirement is fulfilled when a product is delivered that meets the requirements specified. In order to ascertain how the private sector specifies quality, the questionnaire respondents involved in this study were asked: (1) Is it realistic to specify a quality level? and (2) What term of specificity is recommended? The results were:

Question 1: Is it realistic to specify a quality level?

<u>Yes</u>	<u>No</u>	<u>No Response</u>
83%	15%	2%

Question 2: What term of specificity is recommended?

1. Performance Specification	35%
2. Design Specification	24%
3. Acceptable/Unacceptable Defect Levels	21%
4. Part Number	7%
5. Catalog Description	5%
6. Brand Name	4%
7. Market Grade	4%

In the above questions, respondents responded to more than one answer option. The percentages shown represent a weighted finding.

As the questionnaire results indicate, the overwhelming industry method is, as in government, to specify precisely what is desired. Levels of quality are not a rational measure either in government or industry and the term, "level," adds confusion in most cases. When product characteristics are defined, quality is defined.

Government personnel assigned the responsibility for acceptance of material take title to the material based on their conviction that the material meets all requirements. Despite this premise, there is still much discussion about lack of quality and quality complaints.

There is a need to provide a bridge between the DoD quality definition and a quality product definition. One aid in providing this bridge or gap in transition may be to add a definition of a quality product. A suggested definition is the following: A quality product is one that has a design incorporating all of the users requirements and, in fact, conforms to all design requirements both static and dynamic. There are two principal advantages to incorporating this definition in policy: (1) it is hardware oriented, not a theoretical concept, and (2) it incorporates the concept of quality (excellence) of design. It will provide recognition that designers have a quality responsibility that must be discharged if a quality product is to be produced.

In the interests of clarity and consistency, the following terms and associated definitions will be used consistently throughout the remaining sections of this report. Some definitions are direct quotes, as indicated by the reference, others are direct recommendations from this research.

- (1) Management Quality Characteristics - Those instructions which relate to administrative aspects of Section 4 of Specifications or other technical product descriptions such as classification of examination and tests, sampling, lot formation or other pertinent inspection information not directly associated with a specific test or examination.
- (2) Product Quality Data - That data which is derived from the inspection of, and relates to the degree of conformance with, design requirements.
- (3) Product Quality Requirements - Those specific product tests/measurements/examinations identified which are required to be performed in Section 4 of the Specification, or other product technical descriptions.
- (4) Quality - The composite of material attributes including performance features and characteristics of a given product or service to satisfy a given need. (DoDD 4155.1)
- (5) Quality History Data - That government data which is assembled and maintained and which describes a firm's performance in terms of product quality data and the excellence of quality management systems.
- (6) Quality Management Data - That data which the government representative collects and uses to ascertain the conformance of the contractors quality management system requirements.

- (7) Quality Management Systems - Those standardized requirements identified in Section IV of the DAR as contract quality requirements, e.g., Std Form 32, MIL-Q-9858.
- (8) Quality Product - A product that has a design incorporating all of the user requirements and, in fact, conforms to all design requirements both static and dynamic.
- (9) Quality Policy - Any policy, regardless of the identification of the issuing activity, that establishes policy or results in the establishment of or measurement of product technical requirements.
- (10) Technical Characteristics - All requirements and descriptions that describe the item, material or process. Such descriptions include, for example, character of the material, formula, design, construction, performance, reliability, chemical composition, electrical and physical requirements, dimensions, weights, color, name plates, workmanship, standards, etc.
- (11) Technical Requirement - Those specific product requirements, dynamic (performance) or static that are specified in Section 3 of Specifications or other product technical descriptions.

B. ANALYSIS OF RELIABILITY AND QUALITY POLICY

This section will examine, in broad terms, policy in the general areas of reliability and quality. While the principal quality related documents must be reviewed individually, there is a need to have an overview of policy in order to have a sense of the individual documents as they interact with each other.

1. Reliability

Methodology has been developed and is in use that permits a reasonable clear specification of requirements. The method of arriving at requirements was discussed in Section II. The most commonly accepted method of measuring reliability is contained in MIL-STD 781, Reliability Design Qualifications and Product Acceptance Tests: Exponential Distribution, 21 October 1977. This is the C or third version of MIL-STD 781.

MIL-STD 781 provides a reasonably rational assessment method for determining the time related performance of equipment. There has been a wide divergence of opinion as to the accuracy of these projections. In 1973 on one aircraft, the reliability prediction of the Bomb Navigation System was shown to be higher than field performance by a factor of 20 to 1.²⁰ In 1976, based on 16 types of avionics equipment in nine types of aircraft the disparity was shown to an average of 5.88.²¹ Presumably, these equipment reliability values were derived from an older version of MIL-STD 781. It is probable that the current version of the standard will result in a better prediction.

²⁰ Avionics Reliability Study, Phase 1, Hqtrs. AFSC XRX

²¹ Rome Air Development Center, Operational Influences on Reliability, RADC TR-76-366, December 1976

Reliability is normally a relationship between performance and time; that is, performance at required levels for some defined period of time. It may, however, take other forms such as in the case of a missile engine that must work only once, i.e., a one-shot device. The normal specification is in terms of mean time between failure or MTBF; this term is commonly known and recognized and specified. The test normally consists of operating the equipment in its use environment for the period of time necessary to provide some level of confidence that the equipment has met its MTBF requirement.

Reliability demonstrations are a difficult and taxing process. There are both technical and administrative problems to be overcome. Technical problems of demonstrating reliability will not be discussed. One category of administrative problems that arises, results from the difficulty of establishing a clear cut refereeing or decision making process that will result in quick and proper determination as to whether a failure will be counted or not. Failure must be categorized promptly and accurately, and determinations must be made regarding corrective action. Improper management here will certainly lead to inaccurate predictions negating the benefits of sound statistical planning. Test results may result in the delay of a program at a crucial time if they indicate non-conformance with requirements.

When a failure occurs that threatens the schedule or indicates that the required performance is not available, the program manager is subject to severe pressure from his management and from the contractor and even from his staff.

Contractor pressures obviously result from a desire to keep the program progressing on schedule. Program manager assignments are commonly perceived as a career enhancement assignment, particularly when the program is concluded meeting all requirements of performance, schedule and cost. Reliability testing results are highly visible and a failure which may lead to redesign can cause a significant delay with all of the attendant program complications and possibly a direct impact on costs and schedule. The Defense Science Board has stated that "...specialists in the 'ilities' operate under a professional set of values and objectives which are largely independent of, and not obviously directly supportive of the goals of program timeliness and achievement of established acquisition schedule."²²

The program manager, although highly motivated to have a successful program, is faced with a wide variety of major participants whose motivations may be opposed to each other and some times to him. Some of these participants include contractor personnel with incentive provisions in a contract, and staff reliability experts who expect the equipment to meet performance, e.g., reliability, requirements established in consonance with the user and his operational needs. It is difficult to find flaws in reliability policy. It is possible though that unrealistic expectations resulting from user needs that may extend the limits of achievable technology coupled with optimistic performance promises from industry can make the policy unworkable in practice.

²² Defense Science Board, Office of the Under Secretary of Defense for Research and Engineering, Report of the Acquisition Cycle Task Force, Washington, D.C. 15 March 1978

2. Quality

As in the case of reliability, quality methodology has been developed. Unlike reliability, however, there is no universally agreed upon measure of quality such as mean time between failure. At this stage of organizational development, reliability and quality are considered to be so different that they are distinctly separate organizations and the reliability dimension of product quality is likely not to be a quality consideration.²³

MIL-STD 961 contains instructions for the preparation of specifications. The primary elements of specifications are Section 3 which provides a technical description of the product and Section 4, the quality assurance section, which provides inspection instructions. Through the technique of tiering or incorporating other specifications, e.g., AIR-STD 12/19(2), Electro Magnetic Compatibility Test Methods for Aircraft and Electrical Equipment, instructions detailing test procedures are incorporated, or sometimes specific instructions are contained in the contract proper,

Quality is normally specified in terms of material characteristics dimensions and instant performance parameters, e.g., shaft speed 1600 RPM. If it is further specified that the device must operate at 1600 RPM for 10,000 hours with no more than 10 interruptions (or failures), then a reliability factor is added, i.e., an MTBF of 1,000 hours. The instructions that are contained in MIL-STD 961 constitute the principal documentation devoted to how to specify quality characteristics.

Product quality requirements are normally specified by product designers as a routine task compared to the creative aspects of design concepts. Designs have a characteristic of quality in the sense of their inherent capability to provide the performance which is required. Design technical characteristics in military applications are usually limited to the functional, as opposed to esthetic, parameters. This is as opposed to commercial products where appearance has an important impact on sales and subsequently on the firm's success or failure. The designer is responsible for the quality of the product's design. If the user needs are not clearly specified, the product's ability to perform the intended function will be a matter of chance. The degree of conformance to a misstated design requirement is meaningless and suitability or fitness for use will not be achieved.

The central thrust of the DoD quality assurance policy is the contractor responsibility concept. This concept, basically stated, is that the contractor is responsible for producing a product that meets all requirements and proving that it does before it is delivered to the government. This concept is reinforced with numerous standard contractual devices to assure that the contractor is, in fact, certain that the material does conform to the requirements before he provides it for acceptance.

These devices fall into two categories: (1) a group of specific clauses for inclusion in the contract that normally incorporates penalty provisions in the event of defective material, and (2) a family of management

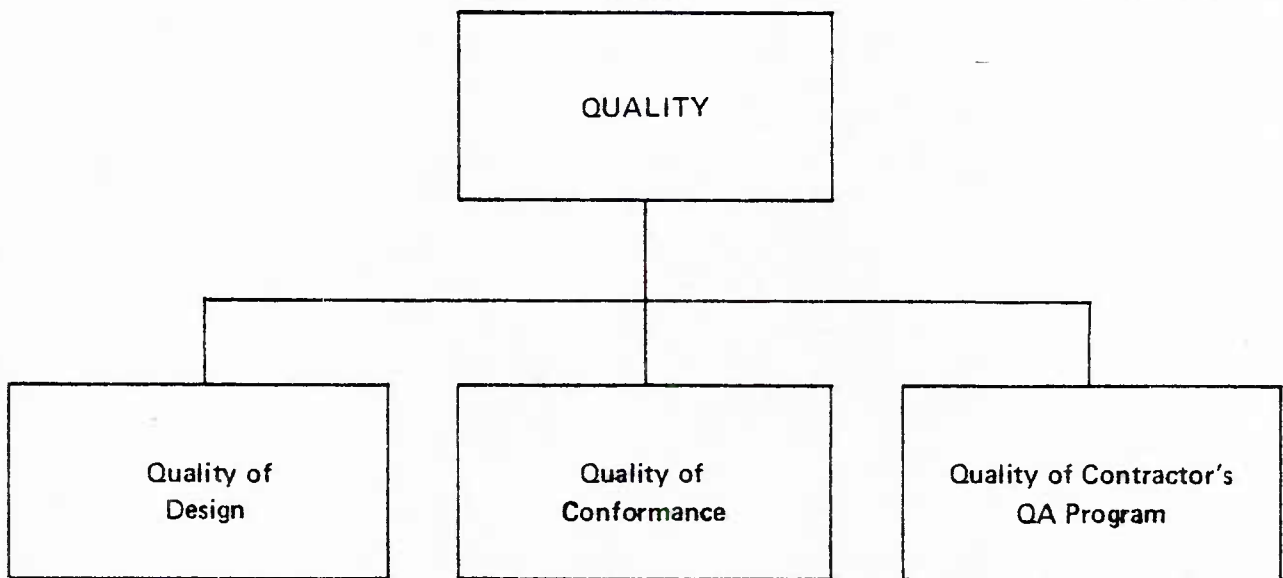
²³ Weiss, Bernard L., Observations and Recommendations to Enhance Product Quality in the Operational Environment, (Quality Horizons) Air Force Systems Command, 1979

systems that require the contractor to implement certain quality management related techniques. These management systems, their selection for inclusion in contracts and their enforcement have come to be a primary consideration for quality assurance personnel. The management system most commonly incorporated in AFSC system contracts is MIL-Q 9858A, Quality Program, and it is commonly reinforced with MIL-STD 1520A, Corrective Action and Disposition System and MIL-STD 1535A, Supplier Quality Assurance Program Requirements.

Quality, in light of the observations above, is comprised of three elements--quality of design, quality of conformance and quality of the contractor's quality management system. An illustration of these elements, or the quality triad, is shown in Figure IV-1.

Figure IV-1

Elements of Quality: The Quality Triad



The three elements of quality (quality of design, quality of conformance, and quality of the contractor's management system) are all measured or monitored in various ways and by differing organizations. Quality of design is primarily the responsibility of the engineering element. The quality of the product design is vital to the development of a successful system. Obviously, a poor design will produce a system below the potential it would have with an improved design. The design review process is utilized by many contractors, however, there is little uniformity in who attends the reviews.²⁴ USAF policy guidelines directs quality assurance personnel to participate. However, the instructions are vague or the emphasis is directed toward produceability and testability aspects as opposed to quality of the design.²⁵

²⁴ INTEC survey questions 3 and 4, see Appendix A.

²⁵ AFR 74-1 Paragraph 3a, 3c, AFSCR 74-1 Paragraph 10 a (1).

The defined duties of quality assurance engineers are to interface with design engineers and not to consider the quality of design but rather "assure that the design(s) consider quality assurance factors, e.g., process constraints, testing limitations, and tooling concepts as a medium of inspection."²⁶ Quality of design is not identified as an element of the quality engineer's role.

Quality of conformance, the second element of the Quality Triad, has been and remains the traditional role of quality assurance organizations. While that role has remained unchanged, there have been major changes in the assessment of product quality which has undergone drastic changes as a result of the establishment of the contractor responsibility concept and the earlier development of sampling as a government quality assessment technique. Policies and procedures for the USAF in-plant quality assurance program are contained in AFCMDR 74-1, Procurement Quality Assurance Program. There currently is in preparation the AFSC Quality Assurance Handbook which provides further policy and guidance, and relates primarily to the quality assurance function in the major system acquisition process.

AFCMDR 74-1 establishes the procedure by which the USAF inspector accepts or rejects the material offered by the contractor and it measures the quality of the contractor's quality management system simultaneously. The acceptance of products, which presumes conformance to design requirements, is predicated on confidence that the contractor's quality policies and procedures conform to the terms and conditions of the contract and are complied with by employees.²⁷ A variety of techniques for providing this confidence are utilized including procedure reviews, assurance of conformance to the procedures, verification of the accuracy of the contractor's inspection decision and independent inspection by the USAF inspector. This procedure was originally developed in the late 1950's and has been utilized since then with continuing refinements.

missed the point of CMEP

The quality of the contractor's quality management system, e.g., quality program, is the third element of the Quality Triad. The continuing reduction in quality personnel has led to an increasing reliance on the concept that a good quality program will produce conforming material. This increasing emphasis has led to a concentration of emphasis on the contractor management system. A recent series of discussions with quality personnel in several project offices in the Washington, D.C. area indicated that some personnel had significant misunderstanding concerning the relationship between product quality and management system quality.²⁸

Quality of design is not perceived to be a quality function. Policies relative to design quality are in broad sweeping concepts that relate to overall system performance including life cycle cost. Policy relating to design quality was not located in this investigation and quality assurance policy for quality engineers is concerned with manufacturing/testing factors. In short, quality policy does not relate to design quality.

²⁶ AFSCR 74-1, Paragraph 2 h

²⁷ AFCMDR 74-1, Paragraph 5-11, 3 January 1977

²⁸ Interview with personnel from the Defense Material and Standardization Office, 24 April 1980

Quality of conformance is determined by a long-standing in-plant program. The AFCMD approach is fundamentally based on evaluation of production processes with limited product inspection performed to verify evaluation findings. Recent policy revisions require specific Q&A assessments concerned with both product quality and quality planning. Such terms as quality levels, quality characteristics, quality program requirements and quality planning are frequently used, confusing the distinct issues of quality of product versus quality of management.

Quality of the contractor's management system is the dominant feature of quality policy. Its selection for contract inclusion, and its management by the government is thoroughly documented. Quality of management systems appears to be almost synonymous with product quality. The current program is a refinement of a program implemented 20 years ago. Insofar as assessing the quality of the contractor management is concerned, no significant fault can be found with the program.

C. ANALYSIS OF QUALITY RELATED DOCUMENTS

1. OMB Circular A-109

This circular was prepared as a result of Executive Branch and Congressional concerns over the effectiveness of the management of major system acquisitions. It is very broad in nature consisting of a flexible philosophy of system acquisition. As expected in a directive emanating from this level, guidance is broad in concept, it does deal, however, with management objectives. The first objective is that the system should operate effectively in its intended environment and demonstrate a level of performance and reliability that justifies its cost. A second objective is to "provide strong checks and balances by ensuring adequate test and evaluation." A-109, although it does not use the word quality, is obviously concerned with the development of a system that is demonstratively a quality product. Performance and reliability are clearly subsets of overall product quality.

2. Department of Defense Directives 5000.1 and 5000.2

DoDD 5000.1, Major Systems Acquisition, establishes the basic DoD system acquisition policy. It only mentions quality indirectly in the Standardization and Operability Section where logistic supportability is classified as a design responsibility equatable to cost, schedule and performance.

DoDD 5000.2, Major System Acquisition Procedures, provides policy, instructions and procedures for major systems. Paragraph E., on acquisition planning identifies quality as one of several considerations of standardization of design. There is also a requirement for the inclusion of MIL-Q-9858A as a quality management system in contracts. There is, in contrast, in the same section, an entire paragraph of equipment-based requirements for the inclusion of reliability and maintainability goals. There is, by comparison, no mention of inclusion of a reliability or maintainability management system.

The Decision Coordinating Paper (DCP) format includes a section, Enclosure 4, devoted to performance which includes gross overall performance factors and time based, i.e., reliability and maintainability performance. The Integrated Program Summary (IPS) format contains parts that relate to quality directly or indirectly. Paragraph 13, Test and Evaluation, requires test objectives and test results. Paragraph 16, Reliability and Maintainability, requires identification of R&M parameters, achievements and goals for the next phase. This requirement is broken out on a milestone basis, i.e., Milestones I, II and III, and shows an overall picture of reliability and maintainability growth of the system. Government Furnished Equipment is included in this analysis. Paragraph 17 incorporates the Independent Quality Assessment requirements in DoDD 4155.1

These documents are representative of current policy approaches which concentrate on the reliability parameter of overall system quality. The almost total reliance on reliability data for performance data is limiting and is biased toward answering logistics costs questions, whereas the first problem is a system that meets all user requirements. Failure to meet the requirements are most often identifiable early in full-scale development cycle. However, the official (i.e., contract specified performance goal) identification of a system/subsystem problem at the time of reliability demonstration test is necessarily late in the development cycle. DoDD 5000.2 could be improved from a product quality standpoint by the addition of a separate annex which describes product quality of subsystem (or lower level) components in terms of performance goals which are contractually specified.

3. Department of Defense Directive 4155.1

DoDD 4155.1 requires each of the DoD components to establish and manage a "quality program" which fundamentally requires a cost effective management program to assure that material purchased conforms to requirements. It further establishes the basic contract administration relationship between contractor and government quality assurance personnel, commonly called the contractor responsibility concept. It is primarily and properly a management oriented document with limited product related instructions as compared to DoDD 5000.2.

Since this directive must encompass all material purchased by the DoD, it cannot be directed exclusively toward the quality of major systems. It does, however, include requirements for review of the quality of such material. In view of the intent of this study, the following five policies (paraphrased) of particular significance are identified for later consideration:

- (a) Warranty clauses shall be used as a device to hold contractors responsible for their products.
- (b) The DoD components shall consider using incentive fee arrangements for achieving quality goals.
- (c) DoD components shall assure that contractors with a record of providing unsatisfactory products do not receive more contracts.

- (d) DoD components and system managers shall assure the adequacy of quality requirements at DSARC decision points (milestones).
- (e) A product deficiency reporting and data feedback system shall be established.

There are certainly other elements of DoDD 4155.1. However, these are principal policies that relate to the essence of this study.

4. The Defense Acquisition Regulation and Quality Policy

a. General

The DAR is a procurement regulation intended to establish uniform procurement policies. Procurement instructions in it deal primarily with the purchasing function in the areas of contract award and contract administration. It also is concerned with the interface of all of the personnel who have an interest in products under contract and in some cases defines responsibility of such personnel. In the interests of uniform procedures, it has become necessary to standardize certain functions such as the use of inspection stamps and the control of government property.

b. Section XIV, Procurement Quality Assurance

The DAR recognition of the acceptance function with its associated elements of assuring that the product conforms to established requirements is evidenced by the existence of an entire section devoted to quality assurance. The majority of Section XIV is devoted to inter-government quality assurance organizational roles and responsibilities. Section XIV recognizes three government elements: the organization responsible for technical requirements, the purchasing office, and the contract administration office. Product quality considerations are minimal and restricted to areas of the contract-administration office duties. The technical office is responsible for prescribing contract quality requirements such as inspection and testing and are permitted in special cases to issue instructions concerning necessary government inspection. The purchasing office is responsible for contractualizing/formalizing requirements for quality and issuing government inspection instructions to the contract administration activity and for specifying a quality management program for the contractor.

Section IV provides extensive guidance on the contract administration element of quality management. There is no guidance in Section XIV that furthers the DoDD 4155.1 instructions pertaining to warranties, incentive fees, major systems, or motivational considerations or policy.

The section in Paragraph 14-404 does require that selected government records be established which document acceptability of products and processes that could contribute to the requirement noted above, 3(C) for eliminating contractors with poor product quality records. There is no

indication that such information is to be continually updated and provided to a central data source or to be considered as an element of preaward surveys for prospective contractors. There is no reference to other parts of the DAR where selection of contractor or determination of profit is discussed in a motivational concept, i.e., Section 3.

There is also a requirement for the collection of "quality data," 14-405, reported by users during "initial use" which could contribute to both the 3(c) and 3(e) (data feedback) requirements listed above. The Quality Horizons Study noted a continuing need for data feedback and its ultimate use in a comprehensive business strategy concept involving contractor motivational related approaches such as publicity and reduced surveillance.

c. Sections I and III

These sections of the DAR are discussed together since the material they contain is interrelated and associated generally with the prime procurement functions of preparing, negotiating and administering contracts. Product quality is mentioned frequently in these sections as an element of deliberation concerning the prime functions. It is here also that motivation appears as a government issue and policy. And it is here and Section XIV that jointly affect the manner in which the USAF policy is formulated effecting quality administration and product quality.

(1) Section I

Part III of Section I establishes the general policies to be followed in Defense contracting, the first of which is that procurements shall be made on a competitive basis to the maximum possible extent. The section also establishes the time of delivery as an essential element of a contract (1-305). Section I also contains the Liquidated Damages clause (1-305), a penalty oriented mode of motivation. Paragraph 1-313 discusses the procurement of parts, i.e., spare parts. Quality is a consideration in that certain non-standard parts may be purchased from firms that have not provided them before only if adequate data including test results and quality assurance procedures are available for government usage. (See DoDD 4155.1, paragraph C.4.G.)

Product quality information appears as a factor in renegotiation performance reports (1-319 d) (viii) (A). Product quality is a consideration in multi-year procurement policy guidance, Paragraph 1-322 (b) (3) (ii). Policy for warranties is established in 1-324, where contractor quality management system is a factor in that MIL-Q-9858 and MIL-I-45208 are considerations in the application of a warranty. In paragraph 1-326 the component breakout program is discussed. Quality, Reliability and Performance must be evaluated prior to a breakout decision. Paragraph 1-406 identifies the functions that are normally performed by contract administration organizations including Procurement Quality assurance. In paragraph 1-900 responsible prospective contractors are discussed. Recent unsatisfactory performance in quality and delivery are identified in Paragraph 1-902 as examples of what must be resolved prior to making an affirmative decision of contractor responsibility. Contractor quality management system inadequacies are also a listed consideration.

The Qualified Products List is discussed in Paragraph 1-1110. A history of delivery of products not meeting requirements is to be provided to the specification preparing activity. In 1-1803 past performance of contractors is identified as one consideration when determining the need for post-award orientation of contractors.

Part 1-2100 Procurement Planning requires a formalized, structured procurement plan for major development and production contracts. The program manager is expected to consult with various management disciplines such as engineering, production, quality assurance, etc. in preparing the plan. A sample format is included illustrating the elements of the plan and including such areas as Government Furnished Material, R & M, Life Cycle Cost (LCC), Should Cost and Test and Evaluation Approach, etc. However, quality planning is not included as a separate element.

Section I provides considerable policy guidance for procurement. It identified in numerous paragraphs, where the contractor product quality history is to be a consideration in procurement decisions. The contractor product quality data requirements in DoDD 4155.1 and Section XIV clearly have application, if available, to contracting officers. The procurement plan of 1-2100 discusses numerous contract considerations. Product quality information is fractionated into several areas with no clear cut requirement for it or for quality planning as a primary concern. This appears to be a significant omission.

(2) Section III

Section III is concerned with negotiated procurement. The negotiated procurement normally offers opportunity for consideration of the merit of the firm's Quality Management System and the utilization of previously generated quality history data. An early opportunity for the utilization of quality history data may occur when it becomes necessary for the preparation of a Determination and Findings (D&F). (3-301)

There are numerous contract types identified in Section III including principally, fixed price and cost reimbursement. Either of these types may include some type of incentive. Incentives may be based on a variety of contract objectives depending upon the issues surrounding a particular procurement. Examples include cost incentive, equipment performance incentive, or in the case of objectives which are less clearly definable, an award fee approach may be utilized. Incentives may add to profit or take away from profit or may be limited to either case.

Section III is where the principles of contractor motivation are identified and discussed and where other contracting principles are found which may unintentionally impinge on contract objectives. It is in Section III that the principle of profit is identified as the basic motive of contractors. Contracting personnel are advised that the contract type selected and negotiations surrounding it should "ensure that outstandingly effective and economical performance is met by high profits, mediocre performance by mediocre profits and poor performance by low profits or losses." It is expected by DAR preparing officials that the application of these objectives on a contract by contract

basis will normally result in a range of profits. It is recognized also that there may be a time in the contract life that the profit motive is secondary and that technical and cost risks may reduce the effectiveness of profit as a motivator. In the final analysis, however, the contract type selected should, and its provisions should, tie profits to the contractor's efficiency in controlling costs and meeting desired standards of "performance reliability, quality and delivery," (3-401). In other words, quality/reliability should be a major consideration in contract formulation.

The Cost Plus Award Fee (CPAF) (3-405.5) contract differs from the usual incentive type of contract in that it provides for awarding an incentive fee in contract areas where the degree of achieving or not achieving success is not susceptible to finite determination. The CPAF fee is positive in that it does not provide for reduction. It is composed of two parts, a fixed amount that does not vary with performance and a separate award fee that is believed will motivate contractor personnel to improve on what may be their normal performance. The CPAF concept is applicable to services where feasibility is known but degree of success must be based on a subjective evaluation of the services performed. This element of the CPAF concept makes it applicable to contractor management systems such as those imposed in the area of quality assurance.

3-405.5(h) states that "in certain cases, it may be desirable to motivate and reward a contractor for management performance over and above that which can be objectively measured and incentivised under other forms of government contracts."

The CPAE, or award fee provisions should be evaluated to determine performance at stated intervals during the contract performance and contractor personnel should be made aware of the findings. If partial fee payments are made at each evaluation period, it is expected that the profit motive will induce the contractor to improve poor performance or continue good performance. It is also suggested in 3-405.5(e) that consideration should be given to constituting a board to evaluate performance and to afford contractor personnel the opportunity to present his own evaluation.

Firms who have had experience with award fees were asked in the questionnaire to indicate the impact they believe it would have on material quality. Their responses were as follows:

<u>Negative Impact</u>	<u>No Impact</u>	<u>Slightly Beneficial</u>	<u>Very Beneficial</u>	<u>No Response</u>
0%	11%	18%	16%	55%

Forty five of the 82 firms answering the survey did not respond, giving a measure of the degree of usage of the award fee in government contracts. The award fee has an unusual characteristic in that it is simultaneously a financial and psychological incentive. Discussions with contractor personnel indicate a belief that the corporate and government attention drawn

to the quality organization involved in an award fee process is in itself a positive motivator. The profit motive is obvious. However, it may well be overshadowed as a motivator by the psychological characteristics of the award fee process.

When the 82 firms answering the survey were asked to rate special bonuses or cash awards, and official recognition in terms of their ability to motivate employees to strive for high quality workmanship levels, their answers were:

	<u>No Benefit</u>	<u>Slight Benefit</u>	<u>Significant Benefit</u>	<u>Best Method</u>	<u>No Response</u>
Official Recognition	0%	4%	54%	39%	3%
Special Bonus/ Cash Awards	12%	35%	37%	10%	6%

*Because of the
if it's paid out to
employees.*

These responses clearly show the perspective of these respondents toward the increased recognition that is inherent to the award fee method of contracting. Employees in this sense are those that will necessarily be recognized by upper level management as having a specific role in increasing profits and improving relationships with the customer. There is also the direct communication recognition established due to the interaction on a horizontal level between contract personnel performing the award fee task and government personnel evaluating it. It has also been found that while the award fee contract may be more complex to administer, it does require a clear determination of requirements and identification of areas of emphasis and a corresponding understanding of what is important to the government. Research findings of other investigators also confirm that the profit motivation is not the only benefit resulting from the use of the award fee. Professors Hunt and Conjeski have stated, "It also serves a broader program/project control function, stimulating and structuring a steady flow of information across organizational boundaries." ²⁶

Most investigators have found and discussed positive aspects of CPAF contracts. These findings, however, are not exclusively positive. The need for a structured governmental management effort to assess performance and decide on fees to be awarded could obviously have a debilitating effect on manpower requirements. Potential problems encountered on one major system were described by one author as follows: ²⁷

- o Administrative expense (time, men and material) to evaluate the firm's performance and make a fee determination, i.e., difficulty in convening the fee evaluation board and lack of time of board members for evaluation.

²⁶ Hunt, Raymond G. and Raymond T. Conjeski, The Award Fee Method of System Acquisition, State University of New York, Buffalo 1979

²⁷ Brown, Jerry V., The Award Fee Incentive: Management Considerations Regarding its Application to Research and Development Contracts, Defense Systems Management College, Fort Belvoir, Virginia, November 1976

- o Not funding all of potential fee; in effect, signaling to contractor personnel a possible lack of financial determination on the part of the government.
- o A delay in paying award fee having an adverse effect on the contractor in cash flow planning.

It was reported by the Logistics Management Institute that there was no compelling evidence (1968) that cost incentives were working. The study did conclude, though, that the use of incentives produced "more thorough government acquisition planning and more complete and precise communication of procurement objectives to contractors."²⁸

Despite the problems that may be encountered, the Award Fee concept is a methodology that has the potential of a positive influence on product quality. It must be accepted, in the lack of evidence to the contrary, that USAF personnel are accepting only material that conforms to requirements. Quality management improvements, however, on the contractor's part should lead to a reduction in non-conforming material which is rejected and must be replaced, or defective material which can be corrected. These situations underscore the contention that quality and cost effective productivity are opposite sides of the same coin and that, therefore, quality improvements lead to reduction in costs.

Application of the Award Fee concept to quality management is consistent with the three requirements for a successful application, which are:

- o its measurement is possible (subjective)
- o it is susceptible to contractor control
- o it is relevant to contract goals

Product quality is discussed directly or indirectly in several other perspectives in the DAR, Section III. These are discussed in the same sense as they are in Section II. It is possible that product quality considerations are summarily dismissed in these discussions. This could occur as a result of product assurance concentration on the quality management system aspects of contracting.

Paragraph 3-808, which is concerned with profit/fees in cost reimbursement contracts previously provided an opportunity for practically mandating the utilization of quality history data. When a contract profit was based on cost analysis, the government negotiator's profit objective was, among other things, to reward contractors with a good quality record and penalize those whose performance is poor. This, in effect, said that a contractor's quality history is a proper element of deliberation when establishing profit factors.

²⁸ Logistic Management Institute, An Examination of the Foundations of Incentive Contracting, Washington, D.C., May 1968

In September, 1976, in the Defense Procurement Circular (DPC) 76-3, quality and delivery were deleted as considerations from the weighted guideline method of determining profit objectives (DAR 3-808.4). Other changes were made in the guidelines as well. The deletion of performance as a consideration was explained as follows:

"Past performance as a profit determinant has been deleted from the weighted guidelines. No objective measure of past performance exists and the use of this factor has been erratic and of little significance in arriving at a negotiated profit. This factor will, however, continue to be used in the source selection process." The guidelines now consist of (1) contractor effort, (2) contractor risk, (3) facilities investment and (4) special factors.

DCP 76-3 identified the principal procurement objective as "obtain a quality product, delivered on schedule at a reasonable price." The deletion of performance as a consideration in the determination of profit appears to take away a strong motivation to deliver conforming material on time and within established costs. 3-808.4 does still provide the opportunity to introduce "other" considerations under special factors as there appears to be no reason why an assessment of past performance could not be introduced under the section if a consistent methodology were used which provided a measurable past performance factor.

D. SUMMARY AND FINDINGS

1. Motivation

The DAR presumption of profit as the prime motivation of the firm is normally correct in the classic buyer/seller relationship. As discussed in other parts of this report, however, on any particular contract, profit may not be the prime motive of the firm, depending on the life phase of the firm and its particular goals at the time of contract formulation. The DAR presumption of profit must have, as an element of it, a corresponding presumption of purchases in a free market situation; an assumption that is questionable at best. Also, the profit/quality relationship assumption must include the premise that the profit will motivate those individuals who can directly influence product quality, e.g., the operators as defined earlier. Figure IV - 2 illustrates contracting techniques vs contractor personnel.

The DAR is essentially silent on motivational guidance/management in contrast to other management systems and programs. The DAR contract situation does not transmit to contractor employees the sense of urgency and participation that is present in commercial air carrier programs where there is immediate feedback of problems when quality problems impact commercial transport systems. The DAR provides no significant encouragement or direction for the firm to develop motivational programs that will permit the operator to have a personal sense of satisfaction or failure depending on the success or failure of the USAF systems in the field.

Despite the reaffirmation that profit is to be used to motivate the firm, aside from its effectiveness or non-effectiveness, product quality history of previous contractors is a minor consideration in determining

profits on cost reimbursement contracts and is of limited importance in the source selection process. Even if product quality history was a major consideration, it is unlikely, under the present methods, that it would be available in any cohesive usable form due to the current lack of a system for constructing and maintaining the firm's quality history.

The DAR principally is concerned with the instant contract at any one point in time. There is no consideration of developing a government strategy that will understand the motives and concerns of the firm. The firm, by comparison, may have a predetermined corporate strategy that will color its negotiating approach. As a minimum, its approach will be affected by the firm's pre-established hierarchy of needs. The DAR standard contract approach clearly is at a disadvantage in negotiations with a firm which by contrast, is following a predetermined corporate strategy.

A collateral profit question is how does simple profit rank as a reward on contracts where there is reimbursement for an overhead which may result in maintaining hundreds of employees in a reimbursable overhead situation. This question is not answerable in this report. However, it is worthy of serious investigation. In some cases, particularly very large firms, profit may be largely inconsequential when compared to overhead related charges.

2. Quality

Product quality is a function of the quality of design and the degree of conformance of the product to the design. Quality of the product design is first dependent upon an accurate definition of and translation from the user needs into product requirements. The second part of the product design that must be considered is its excellence in terms of the ability to perform the necessary functions for the necessary duration of the product's life. These first two conditions of design must be achieved since the conformance of product to a poor design has limited benefits.

Product quality is an all encompassing term. There is no logical division or distinction between static characteristics, e.g., material or dimensional, instant performance testing and time dimensional testing, i.e., reliability.

Quality policy is oriented toward the conformance element of quality. It is comprehensive in organizational management aspects and concentrates on the production stage of the life cycle. The policy emphasis concentrates on assuring that proper quality management systems are incorporated in contracts and that the firm is in consonance with those system requirements.

Reliability policy by contrast is product centered. Reliability organizational concepts can accordingly be simpler, and are. Quality considerations are in essentially all contracts, as opposed to reliability requirements which are in relatively few contracts. The reliability/management problems are much less complex and management controls/policy appear to be more simple and straightforward.

The significant differences lies in the reliability specialists involvement in establishing and influencing the quality of design in the early or pre-production phases of the life cycle. Quality personnel, by comparison, examine established requirements to plan how to assure conformance. SAMSO-Std 73-2C (ELECTRONIC PARTS, MATERIALS, AND PROCESSES FOR SPACE AND MISSILE APPLICATIONS; STANDARD CONTROL PROGRAM FOR) is the only significant example found where a quality organization is involved in influencing the quality of product design.

The organizational and conceptual barriers between Quality and Reliability organizations does not have a positive influence in that it inhibits communications. It also effectively eliminates the thought that reliability is an element of product quality. The quality/reliability organizational realignments discussed in the Quality Horizons study will ease organizational constraints if accomplished. However, such a re-organization will have a limited impact, and will not solve the greater issue of the identification of design quality as a responsibility to be recognized and a task to be systematically accomplished.

68 A

Figure IV - 2 .

V. ANALYSIS OF VALIDITY OF QUALITY
ASSURANCE AND RELIABILITY APPROACHES

V. ANALYSIS OF VALIDITY OF QUALITY ASSURANCE AND RELIABILITY APPROACHES

A. GENERAL

It is difficult to find fault, in principle, with any USAF policy relating to the management of the quality assurance process. No evidence has been seen that indicates any substantial amount of defective material is entering the inventory. All of the existing policy reviewed has a positive effect on product quality and while there is room for improvement, none is so defective that it should be abandoned. Improvements are possible and recommendations are made elsewhere in the report. In general, the policy is to maintain a quality assurance presence and influence in all of the life phases of the product from conception to disposal. When the various life cycle phases other than production are examined in detail, however, there are few functions that have significant influence on product quality. In order to recommend more positive identification of policy to continue or discontinue, it is necessary to examine the principal functional areas of quality assurance as described in AFR 74-1.

B. DESIGN AND DEVELOPMENT

A quality role in the R&D process is essential if the USAF is to influence the design element of product quality. The traditional emphasis on quality planning to assure that conformance to requirements can be confined is necessary and should be continued. The recently added requirement for product assessments at the end of the demonstration and validation phase and the full-scale engineering development phase should be beneficial.

AFR 74-1, Paragraph 3d, provides an opportunity to introduce quality or excellence of design as a prime management consideration. These instructions are hampered by poor definition, i.e., quality characteristics. However, it identifies a missing aspect of development which is an assessment of design quality. If these instructions result in traditional quality assurance assessments of design only in terms of conformance measurements problems, the opportunity to truly have an independent assessment of design will not be fulfilled. It is conceivable that the function insofar as design assessment is concerned, must be performed by other organizational elements. Who does it is immaterial to the objective. This requirement should also assure that not only planning for demonstrating performance is achieved/performed but that the testing is performed and the degree of success clearly described.

C. CONTRACTING

The majority of the policy guidance associated with contracting is related to contractor quality management systems or administrative instructions concerning the management systems and other specifications and standards. These instructions are necessary but may be considered routine compared to other instructions relating to such matters as incentives and contractor quality history.

The use of incentives is a relatively new approach to quality in contracting. Product quality incentives have been used in the sense of warranties and more recently, such plans as the Reliability Improvement Warranty (RIW) and Life Cycle Cost (LCC) incentives have been used. The incentive approach appears to have merit and can be considered in terms of either award fee or performance incentive. Current instructions could be expanded upon by elaborating on the alternative of performance versus award fee incentives. Incentives that will emphasize field operational performance are desirable if they can be developed.

The development, maintenance and utilization of data about unsatisfactory products and its review prior to contract award can make a valuable contribution to developing tactics when awarding a major contract. The availability of field performance data is a constant problem which was reaffirmed in the Quality Horizons Study.²⁹ If field data is not provided to purchasing offices routinely, it is unlikely that this requirement to withhold contracts from firms with a poor quality history can be met.

D. CONTRACT ADMINISTRATION

The dominant principle of quality policy in the administration of contracts is the contractor responsibility concept. This concept is coupled with the DoD requirement for some type of quality management system, which if conformed with, provides confidence that the product conforms to requirements. The USAF in-plant approach is essentially a preventive quality program based on identification and monitoring of critical parts and processes, the monitoring of procedures, and an emphasis on elimination of the defects encountered. Acceptance of products is based on confidence that contractor policies and procedures are adequate and are complied with by contractor employees. The present in-plant program, or some variation of it, has been in use for several years. There is no evidence to dispute its success in assuring delivery of products that conform to contract requirements.

Contract administration policy is fundamentally that there should be assurance that products conform to requirements. The system for assuring product conformance is greatly biased toward controlling procedures and processes with limited emphasis on government product inspection or test. In as much as R&D is done in the plant environment, the need for an independent product assessment indicates a need for a confirmation of the findings of in-plant personnel. Other than that apparent question, the effectiveness of contract administration policy does not seem to be in question.

In a sense, the efficiency of the current methodology is under examination in light of such programs as the Defense Logistics Agency (DLA), Contract Assessment Program (CAP), the FAA Quality Assurance Systems Analysis Review (QSAR) and the FAA Designated Manufacturer Inspection Representative (DMIR). The Quality Horizons Program recommended consideration of the Minimum In-Plant Surveillance Program (MIPS). In the case of the CAP program, the DLA does not uniformly support the CAP program nor does the FAA use the QSAR and DMIR approach on equipment purchased by the agency. It does appear, however, that an investigation to determine if more efficient in-plant procedures can be developed would be appropriate at this time.

²⁹ Weiss, Bernard L., Observations and Recommendations to Enhance Product Quality in the Operational Environment (Quality Horizons), Air Force Systems Command, 1979

In accordance with contract guidelines, this study is essentially limited to policy considerations. Without a serious investigation into in-plant methodology, it is obviously impossible to provide an authoritative assessment of the USAF quality assurance program. There are, however, alternatives. As one illustration, the United Kingdom (UK) approach resembles the FAA QSAR program in that there is an assessment of the contractor's program and the award of future contracts is dependent upon a satisfactory finding. The UK quality assurance program results in a smaller in-plant quality assurance staff, e.g., in 1978, 14 at Rolls-Royce, a facility of nearly 20,000 employees. There is no reason to believe their aircraft engines are of poorer quality than, say, Pratt and Whitney engines. While there is no hard data to support the conclusion, an intuitive assessment is that the USAF quality assessment program imposes management controls and enforces them to such a degree that the contractor responsibility concept is a concept that is mostly theory.

In summary, USAF policy must be considered in light of the three elements of quality, i.e., quality of design, quality of conformance to design and conformance to contractor management system requirements. The main effort is directed toward assuring conformance of product through verifying conformance of management systems. The policy that relates to quality of design is limited and unclear in intent. Quality policy also excludes time related product conformance to design, i.e., reliability requirements. Policy is stated in terms that are undefined such as quality characteristics, contractual technical system quality requirements, quality requirements, quality system requirements, quality and technical requirements, essential quality requirements, product characteristics, quality deficiencies, deficiencies, etc. Clarification and consistency in terms would improve quality policy. Quality policy may also be clarified if clear recognition and distinction is made between product quality assessments and quality management system assessments.

Reliability policy depends less on the contractor's management system and emphasizes system performance in reliability terms. Reliability policy establishes a requirement for equipment reliability performance records. Reliability policy influences quality of design by establishing reliability goals and periodically reviewing them at upper management levels. There is, by comparison, no such review of non-reliability or other quality performance goals. Reliability policy takes into account other contractual incentives such as warranties. Policy also requires an organized effort to collect and analyze reliability and maintainability data on AFSC systems at the Division level. Policy also requires an interface between the Division and the IOT&E and DT&E efforts and a related data bank of findings.

In a comparison of policy, reliability policy may be seen to generate a high level of visibility based almost exclusively on performance of systems. Quality policy does not concentrate on and highlight product quality, but rather directs more management effort toward administrative controls, resulting in a lower management level of concern and visibility. Quality policy would be improved if it were revised to provide additional emphasis on product quality, as opposed to management system quality.

VI. USAF QUALITY ASSURANCE POLICY AND MOTIVATIONAL VOIDS

VI. USAF QUALITY ASSURANCE POLICY AND MOTIVATIONAL VOIDS

A. GENERAL

The USAF Quality Assurance Program, while virtually silent on motivational conceptual planning and utilization of motivational concepts, nevertheless does contain two subtle and strong motivational aspects. The first is that approval to pay the firm is normally predicated on acceptance of the material after it is inspected to assure that it meets all contract requirements (DAR Appendix I 1-101(b)). The second is the policy that contracts should not be awarded to contractors with a history of providing products or services of an unsatisfactory quality (AFR 74-1. 4.d).

The Quality Assurance Policy is buttressed in other parts of the DAR where contractor history/past performance is to be a factor in awarding contracts and establishing profit levels when profit is negotiated. In theory, these features of USAF procurement methodology should be adequate motivational devices in themselves. There are, however, other considerations such as the characteristics of the Defense market which impact on the effectiveness of these basic motivators.

Government procurement methodology does not mesh as simply with the market as the free market principles permit. This is a consequence of several factors including the public responsibilities of the buyers, the wide range of products and services purchased, the variety of procurement situations, methodology changes resulting from changes in top level management and over-reactions to errors that occur. The DAR itself is profit centered with penalty features and is based on the instant contract without serious attention to development of a corporate approach which could be used in overall procurement strategies and particular contracting/negotiating situations.

Current USAF Quality Policy is management system oriented, has a primary emphasis on the production phase of the life cycle, conveys no sense of urgency to suppliers and is lacking in overt positive incentive methodology. Major contractors are not motivated to respond to the threat/reward stimuli inherently associated with the acceptance act. Specific opportunities to improve the motivational aspects and effectiveness of quality assurance management are available and in some cases they require additional emphasis or changes to some paragraphs of the DAR. Paragraphs VI B, VI C and VI D represent three major opportunities to improve Quality Assurance Policy and are set forth below.

B. CONTRACTOR QUALITY DATA - VOID #1

DoDD 4155.1 and AFR 74-1 both establish the principle that contracting officers will maintain historical quality data that will be used to preclude the award of contracts "to prospective contractors with a previous history of providing products or services of an unsatisfactory quality." In the case of the AFSC, the application of this requirement may be less appropriate since the AFSC retained plants are all large contractors with a lengthy record of supplying material to the USAF and other customers. DAR 3-401(b) advises contracting personnel that their

objective should be to ensure that profits should be directly relatable to performance, including reliability and quality.

A quality history of these large corporations incorporating all elements of the quality triad could be useful in planning for future or newly established development or full-scale production programs. Such a quality history of a firm is more likely to be positive than negative and will undoubtedly illustrate more strength than weaknesses. There are two areas of information that are recognized by some personnel, but traditionally, are not organized and available at crucial procurement milestones. These information areas are twofold: (1) the corporation's general management approach to quality, i.e., the relative position of quality issues in the hierarchy of all corporate goals and issues; and (2) the complete quality histories of systems as they progressed through the life cycle. If this information is organized and recorded systematically on a routine periodic cycle, insight into corporate reactions to quality issues can be utilized advantageously in early as well as late life cycle negotiations. The information would improve parametric analyses capabilities and permit better planning and allocation of resources.

There is a void in that there is no USAF corporate memory providing an organized historical perspective of a contractor's quality performance in developing and producing major systems.

Appendix VI-1, Contractor Quality Performance Evaluation Report, will begin the process of eliminating this void. It will provide quality assurance organizations with an opportunity to capitalize on the motivation that occurs when the firm realizes the three elements of quality performance on a current contract will be examined when a future proposal is considered for award. It is recommended that it be adapted and that the CMD be made responsible for collecting, evaluating and providing the reports to contracting officers. Appendix VI-2 is implementing language proposed for inclusion in AFR 74-1 and AFSCR 74-1.

past history of performance

It is recommended that the contractor quality performance report procedures be adapted on a trial basis. The adaption of this procedure will provide an opportunity to supply contractor quality history in an organized analytical format for the use of those officials involved in contracting negotiations.

C. INCENTIVE CONTRACTS AND PRODUCT QUALITY - VOID #2

The Cost Plus Award Fee (CPAF) approach was a subject of special interest to many persons interviewed during this investigation, both government officials and contractor personnel. The Award Fee approach which permits subjective evaluations as a basis for fee determination is applicable to considering excellence of effectiveness of contractor management systems required and defined by the government, e.g., MIL-Q-9858.

The Award Fee concept has the dual motivational capability of providing psychological rewards to people at lower levels of management by drawing attention to their activities while simultaneously increasing corporate

profits. It also improves communications by requiring a specific judgment of the program in question and by permitting the contractor to examine the judgment. A last advantage is that it results in more considerations and sharper definitions of government objectives. The disadvantage is that it entails a significant administrative burden. The burden arises because it will be necessary to involve numerous personnel at more than one level of government management. The administrative requirements resulting from a careful evaluation and fee determination process does provide protection against arbitrary or capricious evaluations.

The DAR does permit an alternative to the CPAF approach in that it is permissible to use Performance Incentives, not only in terms of equipment performance, but also in terms of the performance of the firm. Although this approach appears to have merit, it was not explored in detail, due to the current emphasis on the CPAF approach. It is recommended that some thought be given at a future date to considering performance incentives as another viable quality assurance management concept.

There is a void in that no methodology has been developed to incorporate the profit motivation in the USAF Quality Assurance Program.

In view of the current USAF field and contractor interest in the CPAF method, it was decided to develop an approach which, while certainly not unique to methods used by the DoD and other Departments, would provide a basic procedure specifically applicable to product quality issues. This approach was taken even though during the term of this contract, AFSC instructions were issued which directed the use of the award fee in the quality area. In view of the findings resulting from the exploration of this technique it appears that the findings will affirm the AFSC decision and there will be benefits to be gained from providing a methodology for consideration.

Appendix VI-3 provides a brief discussion of CPAF contracting considerations and a format which may be applied in a contract as a specific quality award fee provision.

D. DAR MOTIVATION AND PRODUCT QUALITY - VOID #3

The DAR, as has been stressed previously, established the premise that increasing profit will improve the performance of the firm. The unstated assumption underlying this premise is that in some fashion the profit motivator will effect those employees who influence product quality. As also discussed earlier in this report, profit is not necessarily the prime motivational consideration of the firm at all times. Hence, though the profit assumption is true in a general sense, its validity in every contract situation is subject to question. The INTEC survey confirmed findings of other researchers that, while monetary considerations are important to those who can influence quality, there are other needs more complex and often more important to the firm than pure monetary goals. It has also been found that the remuneration of managers correlated well with sales but less closely with profit. For example, in some corporate situations there may be more emphasis on objectives that will contribute to improving market position and assuring future strength of the firm and less emphasis on attempting to maximize profit on a particular contract.

Having postulated that profit is in most cases the dominant motive, the DAR has devoted limited attention to other forms of motivation. Employee morale is discussed briefly in Section 15 as are bonuses, awards and incentives. Despite these limited exceptions there appears to be two primary assumptions: (1) that profit is the principal motivational factor, and (2) that the "contractor" is a finite being who will be responsive to contractual profit schemes. These assumptions are gross over simplifications of complex organizational/people situations. An obvious question is, who will get the profit and who can influence the quality of material and workmanship.

There is a void in that the DAR does not devote sufficient attention to motivational considerations for those non-supervisory personnel and junior supervisors who can directly influence product quality through their own craftsmanship and attention to detail.

The DAR provides no significant guidance which, (1) either encourages the development of programs which will provide motivation, or (2) for sharing increased incentive profits with personnel who are directly involved in defense programs. There is, however, limited guidance in the DAR that contains the rudiments of such guidance which, if modified, or added to, will effect improvement. Recommendations for additions to DAR 1-343 and DAR 15-205 and 15-309 are included as Appendix VI-4.

The above voids and associated recommendations reflect specific methods for implementing and institutionalizing significant changes to the Air Force Quality Assurance Program. They are also intended to serve as devices to modify traditional concepts and approaches to quality assurance management. They do not however, reflect all of the observations that were suggested or encountered during the course of the investigation. While the scope of this study did not permit the development of resolutions to all of these findings, they are identified in appendix VI-5.

Should Be
Reviewed/evaluated by
TM & JAG

CONTRACTOR QUALITY PERFORMANCE EVALUATION SUMMARY

A suggested format, included as Attachment 1 to this Appendix, is designed to provide a uniform format for assessing the contractor's performance and to provide data that can be used to fulfill the requirements of policy guidance that requires evaluation and utilization of contractor performance data. The recommended evaluation summary is divided into three categories: Quality of Quality Management Systems, Quality of Product Conformance and Quality of Design. The assessments are, to a significant degree, judgmental. The absolute data that is included will assist in providing a rationale for the assessments. That data will also, if collected over a period of time, and over a range of products, provide a basis of "normal" data which can be used to successfully evaluate and efficiently administer a particular contract.

In order to assure a thorough understanding of the evaluation process, the evaluator must prepare a written description or rationale of the factors that caused the assignment of the rating which is then multiplied by a value factor to arrive at an effectiveness rating. It is not possible to provide standard rationale in the format due to the diversity in products and contracts. Accordingly, each evaluator should discuss the attached proposed procedure with supervisory personnel. The rationale must take into account the type of equipment contracted for, e.g., systems/subsystems/components, etc.

The summary should be prepared on each contract over \$500,000 at the end of the contract, or annually, if an extended period is involved as in a system contract. The summary should be discussed with the contractor and a copy retained in the plant for future contracting/precontracting activities. A copy will also be provided to the contracting officer and to the USAFCMD.

The individual score for each element/characteristic should be assigned a value in accordance with Table 1:

Table 1

Quality Valuation Ratings

Excellent	91	-	100
Very Good	81	-	90
Good	71	-	80
Marginal	61	-	70
Submarginal	0	-	61

ATTACHMENT 1

RECOMMENDED CONTRACTOR QUALITY PERFORMANCE EVALUATION SUMMARY

Date _____
 Contractor _____
 Contract Number _____
 Contract Date _____
 Value _____
 Number of Items _____
 Evaluator _____

The objective of the evaluation is to provide a continuing assessment of the firm's quality program. The data below provides a standard rational for selected parts of the program. The assessment is limited to these key parts to minimize and standardize the evaluation. The evaluator must assign a rating from Table 1 which reflects an assessment of these activities.

Category 1, Quality of Quality Management Systems

Factor = .6

	<u>Element</u>	<u>Criteria</u>	<u>Rating</u>	<u>Factor</u>	<u>Effectiveness</u>
A.	Quality Program Management	MIL-Q-9858, Para. 3.2	_____	x .2 =	_____ %
B.	Production Processing and Fabrication	MIL-Q-9858, Para. 6.2	_____	x .2 =	_____ %
C.	Measuring and Testing Equipment	MIL-Q-9858, Para. 4.2	_____	x .2 =	_____ %

Total Quality Management System Score _____ %

Category effectiveness is found by multiplying the rating times the factor (.2).

Rating _____ x .2 = _____ %

RECOMMENDED CONTRACTOR PERFORMANCE EVALUATION SUMMARY (Cont'd)

Category 2, Quality of Product Conformance

Factor = .2

The objective of this evaluation is to provide a continuing assessment of the conformance of products to design requirements. The data below will assist the evaluator in making what is primarily a subjective assessment. It will provide one uniform element of the analysis and will provide a continuing evaluation of product conformance. The evaluator must assign a score from Table 1 which reflects an overall assessment of product conformance to requirements.

A. Acceptance Testing Results

- (1) _____ units completed acceptance test with no defects.
- (2) _____ units required retest due to defects.

B. Manufacturing Effectiveness

- (1) _____ major non-conformances were accepted.
- (2) _____ minor non-conformances were accepted.

Category effectiveness is found by multiplying the rating times the factor (.2).

Rating _____ x .2 = _____ %

RECOMMENDED CONTRACTOR PERFORMANCE EVALUATION SUMMARY (Cont'd)

Category 3, Quality of Design

Factor = .2

The objective of the evaluation is to provide a continuing assessment of the contractor's quality of design. The data below will assist the evaluator in making what is primarily a subjective assessment. It will provide one uniform element of the analysis and will provide a continuing evaluation of quality of design. The evaluator must assign a score from Table 1 which reflects an overall assessment of design quality.

Engineering Changes

- (1) _____ Number of Class 1 changes accepted.
- (2) _____ Number of Class 2 changes accepted.
- (3) _____ Number of Class 1 changes that reduced system requirements.
- (4) _____ Number of Class 1 changes submitted requiring further changes to parameters/characteristics revised in earlier approved changes.

Category effectiveness is found by multiplying the rating times the factor (.2).

Rating _____ x .2 = _____ %

OVERALL QUALITY PERFORMANCE EVALUATION SCORE

Overall contractor score is found by summing Category 1 score, plus Category 2 score, plus Category 3 score.

Overall contractor quality rating = Category 1 score _____ %

Category 2 score _____ %

Category 3 score _____ %

Total _____ %

APPENDIX VI-2

RECOMMENDED ADDITIONS TO USAF INSTRUCTIONS

1. AFSCR 74-1

Add to Paragraph 5f:

Provide an analysis of data in the Contractor Quality Performance Reports Center to the contracting officer for all prospective contractors prior to award on each contract with a value of over \$500,000.

2. AFSCR 74-1

Add new Paragraph 8f:

Prepare a Contractor Quality Performance Report at the conclusion of each contract which value exceeds \$500,000. In the event the duration of the contract exceeds one year, a report will be prepared annually. All reports will be provided to the Contractor Quality Performance Report Center at the Contract Management Division and to the Purchasing Office.

3. AFCMDR 74-1

Add the recommended Contractor Quality Performance Evaluation Summary format, as per Appendix VI-1, Attachment 1, to AFCMDR 74-1.

QUALITY AWARD FEE APPROACH

The CPAF contract is described in the DAR 3-405.5 and should be reviewed prior to development of an Award Fee scheme for a contract. In the event that a decision has been made to include an Award Fee feature, it is essential that the Award Fee approach be defined in the RFP stage. The RFP should include an explanation of the Award Fee features and the fee determining procedures that will be employed. The RFP must also identify the criteria that will be used to evaluate the responsiveness of proposals to the Award Fee requirements. The Award Fee Determination Plan (AFDP)* should be included as a separate entity with the RFP package. Considerations should be given to allowing prospective contractors to provide recommendations for possible improvements to the plan as a draft RFP.

When a contract is issued containing an Award Fee clause for quality, it is advantageous to provide limited references to the Award Fee in the contract itself and to retain the AFDP as a separate element. This will allow the flexibility of modifying the AFDP without modifying the basic contract and will simplify the administrative processes. The contract, however, should provide some coverage regarding the Award Fee aspect of the contract including the following:

1. The Base Fee amount, (can be zero but should be substantial, and may be influenced by other Award Fee aspects of the contract).
2. The Maximum Award Fee which can be earned.
3. The time intervals of evaluation and pay schedule and proportion which can be paid in each interval.
4. A provision that fee amounts will be determined unilaterally by the Fee Determination Official (FDO).
5. A provision that FDO determinations concerning Award Fee earned is binding on both parties and not subject to appeal under the dispute clause.
6. A provision for prompt payment of fee earned after each determination without a need for contract modification.
7. A provision allowing equitable adjustment of fee in the event of change orders or other contract modifications. *Can spell problems —*
8. A provision that in the event of contract cancellation the FDO determination relative to the amount of Award Fee available will be final and not subject to the disputes clause.

* Abbreviations shown in Exhibit G, Page 101

The contract should also identify the AFDP by date and title and include a provision that the FDO has a unilateral right to change AFDP coverage. However, it should establish that the contractor will receive notice of changes by some specified number of days prior to the evaluation period in which the changes will be applied.

The amount of fee that can be awarded has a basic limitation in DAR 3-405.6(c)(2). However, the exact amount of the fee must be assessed in light of any other incentive fees that may be a part of the contract. Under ordinary circumstances, the total fee allowed for a contract for Research and Development is limited to 15% of the estimated cost or 10% in the case of a CPFF contract.

The Fee Determination Official and board members must be chosen with consideration of their availability to devote adequate time to the plan as well as their position in the government hierarchy. It is desirable to have representatives from organizations outside of the plant when the plan is employed. In particular, representation from the using command is highly desirable. In the attached format, in some cases, personnel are identified by title. This is only for illustrative purposes. The evaluation intervals are also examples. Attachment 1 is a format which may be used as an Award Fee plan.

ATTACHMENT 1

SAMPLE AWARD FEE FORMAT AND APPROACH

AWARD FEE DETERMINATION PLAN FOR

Contract No. _____ with _____ (firm) _____

Contents

page

- 1 General Terms and Conditions
- 2 Management and Administration of the Award Fee Program ...
- 3 Evaluation Factors
- 4 Award Fee Determination Methodology
- 5 Changes in Plan Coverage

APPROVED BY:

_____(signature)_____ (date)_____

_____(typed name)_____

_____(title)_____

1. GENERAL TERMS AND CONDITIONS

- A. This plan describes the method of administration of the Award Fee provisions of contract no. _____, dated _____, with _____.
- B. The term of the contract is from _____ through _____.
1. The estimated cost of performing the contract is \$ _____.
 2. The base fee is \$ _____.
 3. The maximum Award Fee is \$ _____.
 4. The estimated cost, base fee and Award Fee are subject to equitable adjustments on account of changes or other contract modifications.
 5. The Award Fee earned and payable will be determined periodically by the Fee Determination Official in accordance with this plan.
 6. Award Fee findings and decisions are not subject to the Disputes clause of the contract.
 7. The FDO* may unilaterally change the matters in this plan, as covered in part 5 and not otherwise requiring mutual agreement under the contract, providing the contractor receives notice of the changes at least _____ work (or calendar) days prior to the beginning of the evaluation period to which the changes apply.
- C. The objective of the Award Fee provisions of the contract is to afford the contractor an opportunity to earn increased fee commensurate with the achievements of optimum performance in pursuit of contract objectives and goals.

2. MANAGEMENT AND ADMINISTRATION OF THE AWARD FEE PROGRAM

The following management procedure is established for administering the Award Fee provisions of the contract.

- A. Fee Determination Official (FDO)
- (1) The FDO is Deputy Director SPO
 - (2) Primary FDO responsibilities are:
 - (a) determining the Award Fee earned and payable for each evaluation period as addressed in Part 4.
 - (b) changing the matters covered in this plan as addressed in Part 5, as appropriate.

* All abbreviations are contained in Exhibit G.

B. Performance Evaluation Board (PEB)

- (1) The Chairman of the PEB is Director of Engineering SPO

The following are voting members:

Using Command Representative _____

Director of Contracting SPO _____

Director of Quality Assurance SPO _____

Chief of Quality Assurance AFPRO _____

Other _____

- (2) The Chairman may recommend the appointment of non-voting members to assist the Board in performing its functions.

- (3) Primary responsibilities of the Board are:

- (a) Evaluate the contractor's performance in accordance with the performance criteria set forth in the contract (and/or in this plan). Evaluation methods will include but not be limited to:
 - . performance monitor reports
 - . other reports which provide useful data _____
- (b) Prepare a Performance Evaluation Board Report for the FDO, including the Board's findings and recommendations for each evaluation period as addressed in Part 4.
- (c) Periodically review the evaluation plan and its implementation, and recommend necessary changes in accordance with Part 5.

C. Performance Monitors (PMs)

- (1) The PEB Chairman will assign a PM to each performance area to be evaluated.
- (2) Each PM will be responsible for complying with the General Instructions for Performance Monitors in Exhibit B, and any specific instructions of the PEB Chairman including the following primary responsibilities:
 - . Monitoring, evaluating and assessing contractor performance in assigned activities.
 - . Periodically preparing a Performance Monitor Report (PMR) for the PEB.
 - . Recommending appropriate changes in this plan for consideration in accordance with Part 5.

3. EVALUATION FACTORS

Evaluation requirements are attached as follows:

	<u>Requirements</u>	<u>Attachment</u>
A.	Evaluation Periods and Maximum Available Award Fee For Each	Exhibit A
B.	Performance Factors and Evaluation Criteria	Exhibit B
C.	Scoring Table	Exhibit C
D.	Award Fee Conversion Chart	Exhibit D

The percentages described in Exhibit B, the scoring table in Exhibit C and the conversion chart in Exhibit D are provided as a typical methodology for a general assessment of the proportion of the available Award Fee that has been earned. They provide only sample guidance and a judgmental evaluation of contractor performance and should not be considered to be the results of a rigorous mathematical determination.

4. AWARD FEE DETERMINATION METHODOLOGY

A determination of the Award Fee earned for each evaluation period will be made promptly by the FDO after the end of the period. The method, to be followed in monitoring, evaluating and assessing contractor performance during the period, as well as for determining the Award Fee earned, is described below. Exhibit E-1 summarizes the principal activities and recommended schedules.

- A. The PEB Chairman will assign a PM for each performance area to be evaluated under the contract. PMs will be selected on the basis of their expertise relative to prescribed areas of performance. The PEB Chairman may change PM assignments at any time without advance notice to the contractor but should notify the contractor as promptly as possible.
- B. The PEB Chairman will provide to each PM the following documents:
 - (1) A copy of the pertinent elements of the contract and subsequent modifications.
 - (2) A copy of this plan along with any changes made.
 - (3) Sufficient instructions to perform the PM responsibilities.
 - (4) Any unique instructions concerning PM-assigned performance areas.
- C. PMs will monitor, evaluate and assess contractor performance and discuss the results with appropriate contractor personnel, in accordance with the General Instructions for Performance Monitors (Exhibit E-2), and any other specific instructions or guidance furnished by the PEB Chairman.

- D. PMs will submit monthly PMRs and, if required, make verbal presentations to the PEB.
- E. The PEB Chairman will consider PMRs and request and obtain performance information from other units or personnel that may assist in determining contractor performance. He will discuss reports and information with PMRs and other personnel as he deems necessary.
- F. Promptly after the end of each month, except the final month of the evaluation period, the PEB Chairman will meet with the contractor and discuss overall performance during the period. If requested by the PEB Chairman, PMs and other personnel involved in performance evaluations will attend the meeting and participate in discussions.
- G. Promptly after the end of each evaluation period, the PEB will meet and consider all performance information obtained, summarize preliminary findings, and determine recommendations for coverage in the PEER.
- H. Subsequently, the PEB Chairman will meet with the contractor Award Fee representative and discuss preliminary findings and recommendations. As requested by the PEB Chairman, PMs and other personnel involved in performance evaluation will attend the meetings and participate in discussions. At this meeting, the contractor representative will be given an opportunity to submit matters in the firm's behalf, including an assessment of performance during the evaluation period.
- I. After meeting with contractor personnel, the PEB will consider matters presented by contractor personnel and establish Board findings and recommendations for the PEER.
- J. The PEB Chairman will prepare the report for the period and submit it to the FDO for use in determining the Award Fee earned. The report will include a recommended range of Award Fee with supporting documentation. When submitting the report, the Chairman will inform the FDO whether or not the contractor's representative desires to present any matters to the FDO before the Award Fee determination is made.
- K. The FDO will review the PEER and discuss it with the PEB Chairman and other personnel, as appropriate. If requested by the contractor, or if the FDO considers it appropriate, the FDO will meet with the contractor for discussions. If requested by the FDO, the PEB Chairman and any other personnel involved in performance evaluation may be required to attend the meeting with the contractor.
- L. The FDO will determine the amount of Award Fee earned during the period. The amount determined will include the results of judgemental assessments as well as utilizing the analytical procedures herein. The FDO's determination of the amount of Award Fee earned and the basis for this determination will be stated in the Award Fee Determination Report (AFDR). The report will be signed by the FDO and provided to the contractor as justification for payment of the Award Fee granted.

5. CHANGES

A. Unilateral Changes

The FDO may unilaterally change any matters covered in this plan not otherwise requiring mutual agreement under the contract, prior to the beginning of any evaluation period by timely notice to the contractor in writing. The changes will be made without formal modification of the contract.

B. Method For Making Changes

The method to be followed for changing plan coverage follows. Exhibit F summarizes the principal actions and schedules involved.

1. Any person involved in the administration of the Award Fee provisions of the contract may recommend any changes in the plan which will result in improved performance or improve the Award Fee determination process by providing the recommended changes to the PEB for his evaluation.
2. Any proposed changes will be coordinated with the contractor by the PEB Chairman.
3. Prior to the end of each evaluation period, the PEB will submit changes applicable to the next evaluation period for approval by the FDO with appropriate comments and justification, or inform the FDO that no changes are recommended for the next period.
4. * work days before the beginning of each evaluation period, the FDO will notify the contractor in writing if any changes will be made. If any such notification is not provided to the contractor within the agreed-to number of work days before the beginning of the next period, existing plan coverage will continue in effect for the next evaluation period.

* Numbers of days are to be agreed upon by both parties during contract negotiations.

EXHIBIT A to AFDP FOR CONTRACT # _____

Contract No. _____ with _____

EVALUATION PERIODS AND MAXIMUM
AVAILABLE AWARD FEE FOR EACH

Evaluation Period			
<u>No.</u>	<u>Duration*</u>	<u>Ending</u>	<u>Max. Available Award Fee</u>
1	3 months		
2	6 months		
3	6 months		
4	6 months		
5	6 month intervals to end of contract		

$$\text{Maximum Fee Each Evaluation Period} = \frac{\text{Total Fee}}{\text{Number of evaluation periods}}$$

* Periods and equal fee distributions here are examples only. If the fee is varied for different periods, the evaluation equation must be modified.

EXHIBIT B TO AFDP FOR CONTRACT # _____

PERFORMANCE FACTORS AND EVALUATION CRITERIA

The performance areas to be evaluated are identified below.

The evaluation criteria for each area are attached, as indicated.

<u>Area No.</u>	<u>Factor Identification</u>	<u>Factor Weight</u>	<u>See Exhibit</u>
1	Quality System Management	.25	B-1
2	Production of Non-conforming material	.25	B-2
3	Major Assembly Inspection Findings	.25	B-3
4	Completed End Item Quality Assessment	.25	B-4

EXHIBIT B-1 TO AFDP FOR CONTRACT # _____

EVALUATION CRITERIA FOR PERFORMANCE FACTOR NO. 1

QUALITY SYSTEM MANAGEMENT

Factor Weight .25

Description of Element:

Para. 3 MIL-Q-9858A ✓

The objective of the element is to encourage corporate wide involvement in the quality management system.

Sub-Elements to Consider: ✓

Para. 3.1 Organization, 3.4 Records, 3.5 Corrective Action, 3.6 Costs related to quality.

Evaluation Criteria: ✓

Evaluation will be per MIL Handbook H50, Para. 3.1, 3.4, 3.5 and 3.6 except that complete cost data should be available for prevention, appraisal, and failure, (both internal and external costs).

Basis or Standard for Measuring Performance:

This is a subjective appraisal of a firm's performance as evaluated by the PM. It is to be used in consonance with the narrative instructions in the rating table, (Exhibit C).

Sub-Element Weights:

3.1 - .3	Para. 3.1	Score _____	x .3 =	_____
3.4 - .2	Para. 3.4	Score _____	x .2 =	_____
3.5 - .3	Para. 3.5	Score _____	x .3 =	_____
3.6 - .2	Para. 3.6	Score _____	x .2 =	_____

Total _____

EXHIBIT B-2 TO AFDP FOR CONTRACT # _____

EVALUATION CRITERIA FOR PERFORMANCE FACTOR NO. 2

NON-CONFORMING MATERIAL

Factor Weight .25

Description of Element:

The objective of this factor is to develop a manufacturing process in which the production of defective material is the consequence of only random events.

Sub-Element to Consider:

- (1) Purchased material, (2) machine/process functions, (3) assembly,
- (4) Productivity

Evaluation Criteria:

1. Is there an approved overall company cost factor for manufacturing losses resulting from costs associated with the procurement of defective material?
2. Are man/machine process capability studies performed to analyze production problems?
3. Are process control records maintained at assembly stations that identify recurring defects?
4. Is there a positive program to publicize improvements in productivity resulting from quality improvements?

Basis or Standard for Measuring Performance:

This is a subjective appraisal of the firm's performance as evaluated by the PM. It is to be used in consonance with the narrative instructions in the rating table (Exhibit C).

Sub-Element Weights:

1. - .25	Score _____	x .25 = _____
2. - .25	Score _____	x .25 = _____
3. - .25	Score _____	x .25 = _____
4. - .25	Score _____	x .25 = _____
		Total _____

EXHIBIT B-3 TO AFDP FOR CONTRACT # _____

EVALUATION CRITERIA FOR PERFORMANCE FACTOR NO. 3

MAJOR ASSEMBLY INSPECTION

Factor Weight .25

Description of Element:

The objective of this element is to assure the development of a system to analyze and eliminate non-random manufacturing/assembly/test problems that contribute to end item testing problems, delays and costs.

Sub-Elements to Consider:

All areas where subsystems or major components are given a final checkout prior to assembly into the final item/system configuration. In the interests of focusing attention sub-elements should not exceed 10.

Evaluation Criteria:

The criteria should concentrate on:

1. identification of significant problems
2. analysis as to their cause
3. promptness and effectiveness of corrective action taken

Basis for Measuring Performance:

This is a subjective appraisal of the firm's performance as evaluated by the PM. It is to be used in consonance with the narrative instructions in the rating table (Exhibit C).

Sub-Element Weights:

The evaluation must determine how many sub-elements, (subsystem checkout stations) there are. It is recommended that an equal weight be assigned to each and that a table and scoring procedure similar to that in Exhibit B-1 be prepared, e.g. - *

sub-element 1 - .33	Score _____	x .33	= _____
sub-element 2 - .33	Score _____	x .33	= _____
sub-element 3 - .33	Score _____	x .33	= _____
Total			_____

* The number of elements is immaterial but the total score cannot exceed 1.0.

EXHIBIT B-4 TO AFDP FOR CONTRACT # _____

EVALUATION CRITERIA FOR PERFORMANCE FACTOR NO. 4

COMPLETED END ITEM QUALITY ASSESSMENT

Factor Weight .25

Description of Element:

The objective of this element is to generate a measure of product quality in terms of conformance with design requirements. It provides product conformance information both in the manufacturer's facility and after delivery.

Sub-Elements to Consider:

1. Number of defects found by contractor in final end item inspection/test on each end item.
2. Number of minor waivers granted on each end item.
3. Number of major waivers granted on each end item.
4. Number of defects found by user if inspection is performed.
5. Number of user generated deficiency reports.

Evaluation Criteria:

In-plant final inspection
User inspection activities
User routine deficiency reports

Basis or Standard for Measuring Performance:

This is a subjective appraisal of the firm's performance as evaluated by the PM. It is to be used in consonance with the narrative instructions in the rating table, (Exhibit C).

Sub-Element Weights:

1	-	.2	Sub-element 1	Score	_____	x	.2	=	_____
2	-	.1	Sub-element 2	Score	_____	x	.1	=	_____
3	-	.3	Sub-element 3	Score	_____	x	.3	=	_____
4	-	.3	Sub-element 4	Score	_____	x	.3	=	_____
5	-	.1	Sub-element 5	Score	_____	x	.1	=	_____
				Total	_____				

RATING TABLE

<u>Narrative Grade</u>	<u>Description</u>	<u>Proportion of Maximum Achievable Score Available</u>
Excellent	Performance far exceeds that normally achieved for a similar task. Few errors are made. Management and employee controls outstanding.	90 - 100
Good	Performance exceeds that normally achieved. Above average achievement of all areas of element.	60 - 90
Satisfactory	Performance meet minimum standards. No exceptional management emphasis on quality, problems encountered, routinely resolved.	30 - 50
Marginal	Performance less than expected. Continuing extraordinary efforts required to assure material is meeting requirements.	10 - 20
Unsatisfactory	Performance not acceptable. Material cannot be shipped without government inspection. Quality management system not acceptable.	0

EXHIBIT D TO AFDP FOR CONTRACT # _____

The following table converts achieved Award Fee scores into fee earned.

Performance Scores:

Factor No. 1, Score _____ x .25 = Available % of Award Fee _____

Factor No. 2, Score _____ x .25 = Available % of Award Fee _____

Factor No. 3, Score _____ x .25 = Available % of Award Fee _____

Factor No. 4, Score _____ x .25 = Available % of Award Fee _____

Total % of available Award Fee earned _____

Total % of Award Fee earned _____ x available fee _____ = _____ fee earned.

EXHIBIT E-1 TO AFDP FOR CONTRACT # _____

The following is a summary of the principal actions involved in determining the Award Fee for each evaluation period.

<u>Action</u>	<u>Schedule (Workdays)</u>
PEB Chairman appoints PMs, provides necessary guidance, and informs contractor	as required
PMs assess performance and discuss results with contractor	throughout the period
PMs submit PMRs to PEB	last day of each month
PEB obtains performance information from other procuring activity personnel	as necessary
PEB considers PMRs and any other available performance information	continuing
PEB Chairman discusses overall performance with contractor during period	_____ days after end of each month, except last month in period
PEB meets and prepares preliminary findings and position for PEBR	_____ days after end of period
PEB Chairman meets with contractor and discusses preliminary findings and position	_____ days after end of period
PEB establishes findings and recommendations for PEBR	_____ days after end of period
PEB Chairman submits PEBR to FDO	_____ days after end of period
FDO reviews PEBR and discusses it with PEB, as appropriate	_____ days after end of period
FDO sends AFDR to contractor and contracting office	_____ days after end of period

The PEBC will establish appropriate lists of subsidiary actions and schedules to meet the above schedules, as necessary.

PERFORMANCE MONITORS INSTRUCTIONS

1. Monitoring and Assessing Performance

- a. PMs will prepare outlines of their assessment plans as a part of the PEB documentation. The plan should be discussed with appropriate contractor personnel to assure understanding of the evaluation and assessment methodology.
- b. PMs will plan and carry out both scheduled and unannounced assessment visits; however, before each scheduled visit, the PM should contact appropriate contractor personnel who may accompany the PM, if desired.
- c. PMs will conduct all assessments in an open, objective and cooperative spirit so that a fair and valid evaluation is achieved. This will enable contractor personnel to plan improvements in performance. Positive performance accomplishments must be recognized as well as inadequate results.
- d. After assessments, the PM will discuss the results with appropriate contractor personnel, noting any observed deficiencies and/or accompanying recommendations. Areas of poor performance will be discussed to afford the contractor an opportunity to clarify possible misunderstandings and to resolve deficiencies.
- e. PM contacts with contractor personnel are to be accomplished within the context of official contractual relationships. Any activity or association which might cause, or give the appearance of causing, a conflict of interest must be avoided.
- f. PM discussions with contractor personnel are not to be used to instruct or direct contractor personnel in the performance of a contract.

2. Documenting Evaluations/Assessments

Evaluations and assessments conducted, results obtained, and discussions with contractor personnel will be documented immediately after each such actions by preparing a brief summary of observations and discussions with contractor personnel.

3. Evaluation/Assessment Reports

PMs will prepare a formal PMR in accordance with the following instructions and submit it to the PEB, or others, if appropriate, at the end of each month. Information essential to the PMR element involved should be identified, and a format specified if deemed advisable.

4. Verbal Reports

PMs will be prepared to make verbal reports as required by the PEB Chairman.

5. Performance Monitor Report

The PMR will contain, as a minimum, a record of each meeting or discussion in connection with the Award Fee reviews, including the names of contractor personnel, date of meeting(s), and a brief summary of discussions. Any differences of opinion with contractor personnel must be included with a full and complete discussion of the issues.

EXHIBIT F TO AFDP FOR CONTRACT # _____

CONTINGENCY PLAN FOR CHANGING PLAN COVERAGE

The following is a summary of the principal actions involved in changing plan coverage.

<u>Action</u>	<u>Schedule</u> <u>(Workdays)</u>
1. PEB drafts proposed changes	as necessary
2. PEB coordinates proposed changes with contractor	as necessary
3. PEB submits recommended changes to FDO	_____ days prior to end of each period
4. FDO notifies contractor of changes or that there are no changes	_____ days before start of applicable period

EXHIBIT G - LIST OF TERMS AND ABBREVIATIONS

The following is an alphabetical list of all acronyms used throughout Appendix VI-3:

AF	Award Fee
AFDP	Award Fee Determination Plan
AFDR	Award Fee Determination Report
CAFR	Contractor Award Fee Representative
CPAF	Cost-Plus Award Fee
FDO	Fee Determination Official
FM	Function Monitor
FMR	Function Monitor Report
FPI	Fixed-Price Incentive
ICC	Incentive Contracting Committee
PEB	Performance Evaluation Board
PEBC	Performance Evaluation Board Chairman
PEBR	Performance Evaluation Board Report
PEC	Performance Evaluation Committee
PECR	Performance Evaluation Committee Report
PM	Performance Monitor
PMR	Performance Monitor Report
RFP	Request for Proposal

DAR MOTIVATION AND QUALITY

The following proposed changes/additions to the DAR are recommended as procurement policy designed to improve methods for motivating contractor employees to improve the quality of material produced for the USAF. The changes achieve this by: (1) encouraging cash bonuses and other awards for non-management personnel, and (2) by encouraging the development of effective organized motivational programs.

Add: 1-343 - Contractor Employee Motivation

It is recognized that profit is the basic motive of the business enterprise and accordingly, the Department of Defense utilizes the profit motive to stimulate efficient performance by contractors (DAR 3-808).

The stimulation of businesses to encourage efficiencies through employee recognition and reward for superior performance has traditionally been considered as an internal business management prerogative and has not been addressed. Typically, when firms provide bonuses or other rewards for outstanding performance, it is restricted to management personnel. There has also been limited guidance provided which encouraged the development of organized and officially recognized motivational programs.

In order that all avenues be explored for maximum production and performance efficiency, from both the quality and quantity viewpoint, the Department of Defense recommends that contractors give serious consideration to the establishment of incentive policies to adequately compensate superior and outstanding employee performance through the payment of bonuses and/or other material rewards. These policies which now include management personnel should be extended to non-supervisory and junior management personnel. It is further recommended that considerations be given to the development of carefully designed and effective motivational programs intended to improve the quality of material through improving the efficiency and morale of the work force.

Add: 1.343.1 - Policy

It is the policy of the Department of Defense to recognize that it is to the ultimate benefit of the government for contractors to stimulate internal efficiencies through the utilization of organized motivational programs as well as payment of bonuses and/or other material rewards to its employees for superior performance. Such payments will be considered as allowable items of cost under the provisions of DAR Section 15.

with a ceiling

Add: 15-205.6(L) - Bonuses and Other Rewards for Outstanding Performance

Bonuses and other material rewards paid by the contractor to its employees as additional compensation (over and above regular wages) for superior or outstanding performance are allowable, if reasonable and in accordance with established policies of the contractor.

Revise: 15-309.11 - Employee Morale, Health and Welfare Costs and Credits

The costs of house publications, health or first-aid clinics and/or infirmaries, recreational activities, employees' counseling services, and other expenses incurred in accordance with the institution's established practice or custom for the improvement of working conditions, employer/employee relations, employee morale, and employee performance, are allowable..../
The costs of motivational programs designed to improve the efficiency of employee performance and to improve the quality of material are allowable and are encouraged./..... Income generated from any of these activities will be credited to the cost thereof unless such income has been irrevocably set over to employee welfare organizations.

APPENDIX VI-5

- o No public awareness of quality successes
- o No centralized approach to motivation
- o No sense of urgency
- o DAR assumes profit relates to quality
- o Contractor performance not a Weighted Guideline Factor
- o No quality consideration in procurement plan (DAR 1-2100)
- o System quality other than reliability not emphasized
- o DAR 14 does not interface with other DAR parts
- o Primary quality emphasis is on management system
- o Quality of design and quality of product policy needs reassessment
- o No significant conceptual change to quality assurance in _____ years
- o Quality modifiers confuse definitions
- o Productivity aspect of quality needs highlighting
- o Poor specifications are seen by contractors as serious quality problem
- o No DoD reliability focal point
- o Penalty clauses such as C.O.D. have strong negative motivational implications
- o No centralized orchestration of positive and negative motivational elements of existing policy
- o Excessive management controls may relegate contractor responsibility to theory only

Quality Management Observations

VII. FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

VII. FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

A. BACKGROUND

This report presents the findings of an investigation performed to examine United States Air Force contracting and acquisition techniques utilized to assure the quality and reliability of weapon systems. It was performed by the International Technology Corporation (INTEC) at the request of the United States Air Force Business Research Management Center. The principal objective of the study was to examine the general motivational aspects of the USAF contracting techniques with particular attention to quality assurance and reliability policies, management techniques and practices.

The study methodology consisted of three phases: an examination of current quality/reliability policy; interviews with USAF procurement and contract administration officials and industry officials; and a wide-guaged industry questionnaire. The questionnaire was designed to obtain an industry-wide viewpoint of quality/reliability policy. Existing DoD policy was reviewed and a comprehensive literature search was undertaken to identify other sources of information in the product quality motivational arena. Following completion of the interviews, literature search, examination of the questionnaire results and policy review, the results were integrated to determine what, if any, recommendations should be made.

B. FINDINGS

There are two basic elements of quality assurance policy: the first is the overt policy contained in Section 14 of the Defense Acquisition Regulation (DAR). The second relates to product quality as one part of the overall DoD contracting strategy. The overall strategy has one primary thrust, profit.

Purchasing offices are instructed to increase or decrease profit based on contractor "performance," and quality and reliability are identified as elements of the performance evaluation. From the DAR evaluation, it became clear that profit is for all practical purposes, the single procurement motivational device. Various contracting techniques principally involving profit incentives, have been based on this premise. Reliability policy results in equating profit to performance on instant contracts. Quality assurance policy has clearly not reflected this overall procurement assumption, although there is direction to collect quality history and utilize it to eliminate contractors with unsatisfactory performance history.

The DAR assumption that profit is for all practical purposes the only contractor motivation is of questionable validity on two basic points: (1) research performed on this project and by other investigators indicates that there are numerous motivations other than profit for contractor's participation in the Defense market (these motivations relate to life cycle phases that firms experience as they grow and expand), and (2) profit may not

be the prime objective on some contracts, and contractor negotiations relating to tradeoffs may be based on entirely different goals than what the government negotiators assumes to be the contractor's goals.

Despite the admonitions in the DAR and other policy to relate profit to performance (quality), there are no institutionalized procedures for doing so. In the past, performance factors which contained quality and delivery data were deleted from the Weighted Guidelines negotiating methodology based on a decision that no objective measure had been developed and use of the factor had been erratic. Although performance history is theoretically still retained as a factor in source selection, its effectiveness is limited.

A second profit issue, even if profit is utilized to reward contractors, is its effectiveness and relationship to product quality. Industry does continue to raise the profit question, but any direct relationship between profit and quality is difficult to establish and the investigation in this project failed to find evidence to support the contention that profit directly affects quality. There is an open question relating as to how increased profit affects personnel who are in a position to influence the quality of products. The findings indicate that motivational rewards such as management recognition of good workmanship and performance are more effective than financial rewards.

It is generally accepted that the Defense market is not a classic market in the ordinary sense. The type of products, the highly structured purchasing system, the differing risk exposures and other factors all impact on the normal commercial profit incentive considerations. The DAR negotiating premise that profit is always the single most important factors is a gross oversimplification of a complex people-market environment.

Insofar as motivation per se is concerned, the procurement policy is essentially silent and neither encourages nor discourages motivational programs. Zero Defects, the best known and most recommended motivational program no longer has DoD recognition, although it was reported by interviewees as a positive program with benefits which reportedly have been continued to be utilized by some firms.

No evidence was found in the study which indicated that the USAF was accepting non-conforming material. In addition, most contractors reported that they perceive their product quality exceeds requirements. However, there is ample confusion surrounding the product quality question. Product quality is a function first of adequate definition of requirements, secondly, a design to fulfill those requirements, and lastly, conformance to the design. The USAF quality assurance program concentrates on the conformance element and does so by requiring the firm to implement a product quality management system. Air Force quality assurance efforts then are primarily spent on enforcing the design through evaluation of the management system. Definition of requirements and excellence of design are functions which have little quality assurance involvement, although it is clear that a product conforming to a poor design or a design conceived in error, will result in a poor product from the user's

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view. Numerous contractors reflected the view that poor statements of requirements constitute a serious quality problem. It is probable that many quality complaints have their genesis in design or definition of requirements and are beyond the control of the normal USAF quality assurance sphere of influence.

C. CONCLUSIONS

In summary, the following six key observations relate to DoD procurement (quality and reliability) policy as they affect product/system quality:

- o The DAR premise is that profit and quality are directly relatable;
- o Profit should be related to performance, past or present;
- o When profit is determined utilizing the Weighted Guideline Method, past performance is not a consideration;
- o There is no organized method for developing and providing contractor historical quality data for evaluation in the source selection process;
- o There is essentially no DAR policy relating to motivational approaches that affects junior or non-supervisory contractor personnel; and
- o Section 14 of the DAR does not interface with Sections 1 and 3 on product quality matters.

The USAF in-plant quality assurance program was not examined in any detail in this investigation as it fell beyond the project scope and definition. In general terms, however, the in-plant quality assurance program has been built on the contractor responsibility concept and no major conceptual changes have been made for a considerable number of years. The program is assumed to be effective and it interfaces well with other contract administration functions. The significance of the acceptance role is a principal and vital element of the procurement function which does set it apart from routine surveillance functions. There are other approaches which differ from the current USAF quality assurance methodology such as those used by commercial air carriers which must also be assumed to be effective. When the costs of the large USAF in-plant programs are considered, there may be significant differences in efficiency. Whether or not a more efficient approach can be developed for USAF procurements is an open question that requires a complete examination to resolve.

D. RECOMMENDATIONS

Three principal recommendations to improve USAF contractor quality and reliability policy result from this study:

- o That the proposed contractor performance evaluation summary be implemented, thus responding to the need for an Air Force corporate quality memory.
- o That the proposed Cost Plus Award Fee incentive approach be implemented as a standard contracting approach designed to improve quality.
- o That the recommended additions and revisions to the DAR for introducing additional motivational procedures into the DAR contracting methodology be adopted.

Final recommendation

These recommendations are incorporated in Section VI of this report. Obviously, any program of the magnitude of the USAF quality assurance program is always subject to small incremental improvements. These recommendations are made, however, on the premise that if followed, they will result in significant improvements in the quality assurance function. It is recommended that they be implemented on a trial basis and, if necessary, improved upon and then made an integral part of the USAF quality assurance policy. Other observations relating to the quality program may be seen in Appendix VI-5.

A collateral requirement of this project was to develop a recommended Guidance Document entitled, USAF Acquisition Managers Quality Guide, for use by Air Force quality and reliability assurance managers, contracting officers and acquisition managers.

The guidance document was developed as an adjunct to existing policies and procedures. It was designed to give project managers an overview of how product quality and reliability policy interrelate with other procurement policy and to illustrate how those policies could be used to improve product quality.

Specific procedural recommendations were made to improve quality of design and provide additional product quality data for use in system milestone decisions. The Quality Guide is provided as Volume 2 of this report.

APPENDICES

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APPENDIX A

CONTRACT INCENTIVES FOR QUALITY QUESTIONNAIRE

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APPENDIX A

CONTRACT INCENTIVE FOR QUALITY ASSURANCE

PART I - APPROACH AND ANALYSIS

A. INTRODUCTION

Appendix A presents the results of a questionnaire survey relating to quality assurance, reliability and motivational interfaces. It was conducted by the International Technology Corporation (INTEC) for the USAF Business Research Management Center. The information obtained has been used as part of the research for the investigation.

The objective of the survey was to assess the practices and perceptions of commercial manufacturing organizations in regard to motivational perceptions and product quality relationships. The respondents were primarily firms that were involved in government procurements. A distinct effort was made to include other firms who did no, or at least a limited amount of, government business. The survey was buttressed by interviews with personnel from industry and with government personnel, primarily but not exclusively USAF.

1. Synopsis of Survey Results

The survey was intended primarily to provide insight into motivational perceptions of the industrial element of the purchaser/supplier relationships. At the same time the opportunity was taken to examine other product quality considerations such as how is quality specified and how is it measured and what techniques are used in the industrial environment to encourage the delivery of conforming material. Respondents were given the opportunity to provide their recommendations as to how USAF product quality could be improved.

In general, respondents reported that current USAF quality management systems are good although other systems are also successful, e.g., commercial airline techniques. The respondents basically reported that USAF motivational contracting devices seem to be beneficial although many firms have not experienced them. The questionnaire provided insight into how the industrial community views the relationship between USAF contracting methodology and product quality.

2. Organization of the Report

Part I of this Appendix provides a complete documentation of the survey findings with all results presented. This approach is taken to minimize any interpretative bias. Conclusions drawn are substantiated by questionnaire data.

Section B provides a discussion of methodology used in developing the questionnaire. Section C presents the research results on a question by question basis. Section D contains respondent information and findings.

Part II of this Appendix provides the transmittal letter and sample of the questionnaire employed and Part III lists the respondents who participated in the survey and chose not to remain anonymous.

B. METHODOLOGY

1. Approach

The questionnaire was designed to provide information that could not be reasonably obtained from personal interviews alone or extensive literature searches. It supplements research efforts and studies in the same general field and was intended to elicit information from sources not heretofore approached in USAF or DoD contracting studies. The questionnaire survey approach permitted information to be collected from a variety of industrial managers that could not have been accomplished otherwise.

2. Questionnaire Design

A significant effort was devoted to development of a questionnaire which would provide the maximum information from the broadest possible base with as little time and effort as possible on the part of the recipient. Since the questionnaire would need to be complete in itself, it had to be as comprehensive as possible and sensitive to attitudinal postures within the manufacturing community. It had to be adaptable to a complete spectrum of products and industries and to provide insight into the respondents that would allow an accurate interpretation of results. As a final test of the format, the questionnaires were provided to members of a local chapter of the American Society of Quality Control as a controlled test. The questionnaire was then refined and forwarded to all recipients.

The list of organizations to whom the survey would be provided was developed from two sources. The first was from industrial registers such as Standard and Poors which was intended to assure that a large group of respondents could be developed. Secondly, recipients were identified with the assistance of officials of the USAF and of related industrial associations such as the Institute of Electrical and Electronic Engineers (Reliability Society), American Society for Quality Control and the Society of Logistics Engineers. A total of two hundred and forty five questionnaires were distributed in December 1979 and January 1980, from which eighty two responses were received; a 33 percent return.

The questionnaire was designed with the option of utilizing electronic data processing evaluation procedures. It was later decided, however, because a large portion of the respondents chose to elaborate on their responses, that the subjective evaluations possible from manual tabulations might provide a more meaningful analysis. The manual tabulation, coupled with the relative ease of the material and presentation methodology,

proved to be satisfactory. Analysis is provided either by assigning percentages based on the total number of respondents to questions and by summarizing innovative and open ended questions. In some cases, particular answers were presented in total when some insight or response appeared particularly meaningful, and would not bias the results. In some cases, no comments were provided since the data results were self-evident.

3. Personal Interviews

The objectives of the personal interviews were identical with those of the questionnaire. The intent was to supplement the impersonal questions with questions and answers in a dynamic interview environment. The interviews were to learn more of the general philosophies and beliefs of the interviewees as to how they viewed procurement problems and motivational considerations.

No formal agenda was used and the questions were open ended in order to encourage wide open thought processes and discussions in contrast to simple yes or no discussion limiting questions. Several government personnel were interviewed at the AFSC division offices and at the manufacturers facilities. In all cases, interviewees and questionnaire respondents were assured of the confidentiality of their discussion.

Selected interview results are included, but not in a statistical evaluation.

C. QUESTIONNAIRE FINDINGS

The findings that follow on the next pages represent the data contained in the 82 questionnaires that were returned out of the 245 mailed. Eighty two is a substantial base for statistical purposes and the responses do provide a meaningful insight into the current state of mind of industry personnel. Unless otherwise noted, the numbers shown represent the percentage of responses to each question and "no responses" are included as part of the base. Due to fractional carryovers, totals may vary around 100% slightly. In some cases, analysis may be improved by assigning weights or factors, and this possibility is discussed in some questions and one suggested method is provided. It is believed, however, that it is essential to provide raw data without analysis to permit other analysts to adjust the data response in whatever fashion may be desired.

Many of these questions have been discussed before in other USAF surveys; this questionnaire was designed to provide a useful, up-to-date and valid method of integrated analysis. It is intended to examine motivational perception in industry and to provide a unified and contemporary industry view of quality associated contracting methodology. It also provides insight into quality management techniques employed by industry and views on specifying and measuring product quality.

Analysis of the data shows that industry is confident it is supplying equipment meeting or exceeding requirements. It shows a diversity of opinions about motivational practices, although psychological incentives are seen as a strong motivator, and that profit is not a great concern to

operators, or hands-on employees, as it effects quality. Quality programs are seen as highly beneficial for product quality and inadequate technical descriptions are seen as a major problem.

While the summary could be further expanded based on other areas examined in the questionnaire, it is sufficient to say that there are significant opinions reported by respondents in other areas related to product quality and contracting methodology. Summary analysis has been provided on a question by question basis and further examination of quality issues will require a review of specific points raised singularly in the questionnaire.

QUESTIONNAIRE RESULTS

1. Please describe the type of products your firm is currently designing, developing, manufacturing or maintaining for your primary customers.

	<u>USAF</u>	<u>OTHER DoD</u>	<u>OTHER GOVERNMENT</u>	<u>COMMERCIAL</u>
(1) Electronic	54%	54%	45%	48%
(2) Air Frame	9%	7%	6%	10%
(3) Mechanical	21%	24%	22%	18%
(4) Hydraulic	10%	15%	11%	15%
(5) Munitions	6%	9%	6%	2%
(6) Propulsion	5%	5%	5%	5%

COMMENT:

Questions 1 through 6 give a view of the customers and the types of products produced by contractors responding to the questionnaire. The opportunity to identify other products, (questions 7, 8, and 9), identified a series of miscellaneous products of such a diversity that no significance could be attached to them.

2. Please describe your Quality Assurance and Reliability Program.

(10) MIL-Q-9858A	<u>70%</u>
(11) MIL-I-45208A	<u>50%</u>
(12) NASA NHB 5300.4 Series	<u>34%</u>
(13) FAA-STD-013A	<u>16%</u>
(14) MIL-STD-785	<u>40%</u>
(15) MIL-STD-470	<u>34%</u>
(16) Commercial Standard (please identify)	<u>21%</u>
(17) Other (Note: Some contractors may qualify under several systems)	<u>21%</u>

3. Does your firm normally utilize a design review program? Please check the appropriate answer.

(18) YES 90% NO 6% NO RESPONSE 4%

4. If the answer above is yes, please indicate which functional groups or disciplines normally participate in the review.

	<u>YES</u>	<u>NO</u>	<u>OFTEN</u>	<u>SELDOM</u>	<u>NO RESPONSE</u>
(19) Engineering	67%	0%	21%	1%	11%
(20) Reliability	48%	1%	24%	5%	22%
(21) Maintainability	21%	5%	29%	12%	33%
(22) Quality Assurance	40%	1%	34%	7%	18%
(23) Manufacturing	30%	1%	35%	12%	22%
(24) Your Project Manager	48%	2%	28%	4%	18%
(25) Customer's Project Manager	15%	13%	23%	22%	26%

5. Does your company utilize the handbooks or other standard documents which provide the type of guidance shown below?

- (26) Minimum quality levels to meet selected performance levels

YES 83% NO 13% NO RESPONSE 4%

- (27) Minimum costs associated with selected quality levels

YES 26% NO 66% NO RESPONSE 8%

COMMENT:

These questions (26 and 27) provide insight into the extent to which methodology is available to relate design to quality and costs to quality.

6. If your firm has had experience with any of the following contractual approaches, please indicate the impact you would expect them to have on materiel quality.

	<u>NEGATIVE IMPACT</u>	<u>NO IMPACT</u>	<u>SLIGHTLY BENEFICIAL</u>	<u>VERY BENEFICIAL</u>	<u>NO RESPONSE</u>
(28) Correction of deficiencies	0%	18%	17%	48%	17%
(29) Reliability Improvement Warranty	1%	11%	19%	16%	53%
(30) Life Cycle Cost Incentive	0%	12%	26%	12%	50%
(31) Value Engineering	6%	14%	43%	14%	23%
(32) Failure-Free Warranty	0%	12%	11%	18%	59%
(33) Quality Assurance Program	0%	4%	13%	76%	7%
(34) Reliability Program	0%	1%	21%	61%	17%
(35) Maintainability Program	1%	5%	27%	38%	29%
(36) Liquidated Damages	6%	24%	9%	0%	61%
(37) Design to Unit Product Cost	12%	17%	15%	7%	49%
(38) Zero Defects	4%	18%	23%	11%	44%
(39) Multi-level Acceptance Sampling Plans	2%	17%	28%	13%	40%
(40) Reliability/Quality Incentive	0%	5%	20%	28%	47%
(41) Performance Incentive	2%	10%	17%	32%	39%
(42) Reliability Demonstration	2%	10%	27%	36%	25%
(43) Draft Request for Proposal	1%	12%	21%	15%	51%
(44) Award Fee	0%	11%	18%	16%	55%

COMMENT:

This series of questions provides information as to the respondents opinion of the contribution these techniques can make toward improving quality. The NO RESPONSE column provides insight into the usage of these concepts in contracts. No other programs of consequence were identified.

7. Would/does the inclusion in a contract of any of the contractual approaches listed in question 6 cause the Quality Assurance activities in your firm to staff or plan actions in other than the customary manner?

(45) YES 48% NO 46% NO RESPONSE 16%

COMMENT:

Every program listed in question 6 was identified at least once as causing a change in staffing. Those most often identified were 29, 30, 32, 40 and 42. The CAP program is also identified as one which would result in changing staffing levels.

8. Please identify those of the following factors which have a degrading impact on the quality of materiel you produce.

	<u>NO DEGRADATION</u>	<u>SLIGHT DEGRADATION</u>	<u>SIGNIFICANT DEGRADATION</u>	<u>SERIOUS DEGRADATION</u>	<u>NO RESPONSE</u>
(46) Rush Job/Schedule	8%	39%	34%	6%	13%
(47) Subcontractors	30%	37%	14%	6%	13%
(48) Poor Working Conditions	12%	29%	25%	6%	28%
(49) Poor Specifications	7%	15%	30%	23%	25%
(50) Poor Morale	11%	23%	30%	13%	23%
(51) Job Insecurity	14%	32%	23%	4%	27%
(52) Lack of Pride in Work	8%	22%	37%	10%	23%
(53) Lack of Skills	6%	18%	31%	23%	22%

COMMENT:

These figures provide insight into recognizable problems which contribute to poor quality. Poor specifications and lack of skills are clearly significant problems.

9. Do you believe it is realistic to include in a contract a quality level to be achieved?

(55) YES 83% NO 15% NO RESPONSE 2%

10. If the answer to 9 is yes, what term of specificity would you recommend?

(56) Performance Specification	<u>35%</u>
(57) Market Grade	<u>4%</u>
(58) Design Specification	<u>24%</u>
(59) Brand Name	<u>4%</u>
(60) Catalog Description	<u>5%</u>
(61) Part Number	<u>7%</u>
(62) Acceptable/Unacceptable Defect Levels	<u>21%</u>

COMMENT:

The "specification of quality" and "quality levels" are frequently used terms. This series of questions is designed to show what these terms mean and how quality is specified in practice.

11. Would you describe the materiel that your firm builds as exceeding customer specified quality requirements?

(64) YES 85% NO 12% NO RESPONSE 3%

COMMENT:

Allegations of "poor quality" are frequently made. These answers clearly indicated that most contractors believe they exceed requirements. The 12% NO must be viewed not as to meeting requirements but as exceeding them. One respondent answered as follows, YES, "forced by in-plant AFPRO."

12. Do you feel that the inclusion of life cycle cost type of incentives, e.g., Reliability Improvement Warranty or fixed price maintenance options in design/development contracts, would/does result in measurable improvement in the quality of materiel normally produced by your firm?

(65) YES 39% NO 52% NO RESPONSE 9%

13. If you were to assign responsibilities for product defects which occur in your plant, what proportions of that responsibility would you assign to each of the following categories of personnel?

(66) Corporate or Top Level Management	<u>31%</u>
(67) Middle Level Management	<u>11%</u>
(68) First Level Supervisor	<u>14%</u>
(69) Operators or Non-Supervisory	<u>25%</u>
(70) Design Engineers	<u>19%</u>

COMMENT:

This question was intended for correlation with normal motivational contracting procedures. It affirms that all levels of the organization share responsibility for product defects. The operator/non-supervisory category does not differ significantly from the 20% generally assumed to be controllable by that group.

14. How do you rate the following management techniques or methods to assure that your firm is obtaining materiel from suppliers that conforms to requirements.

	<u>NO BENEFIT</u>	<u>SLIGHT BENEFIT</u>	<u>SIGNIFICANT BENEFIT</u>	<u>BEST METHOD</u>	<u>NO RESPONSE</u>
(71) Your Inspectors in Supplier's Plant	4%	29%	39%	25%	3%
(72) Receiving Inspection	0%	12%	56%	32%	0%
(73) Supplier Surveys	0%	44%	46%	7%	3%
(74) Clear Definition of Requirements	0%	0%	46%	54%	0%
(75) Financial Incentives	17%	46%	27%	4%	6%
(76) Psychological Incentives	23%	48%	16%	1%	12%

COMMENT:

It is significant to note that "clear definition of requirements" stands out as a major concern in addition to the expected techniques such as receiving inspection and profit. See question 49.

15. How do you rank the following factors in terms of a problem causing the production of non-conforming materiel?

	<u>NO PROBLEM</u>	<u>SLIGHT PROBLEM</u>	<u>SIGNIFICANT PROBLEM</u>	<u>SERIOUS PROBLEM</u>	<u>NO RESPONSE</u>
(77) Poor Working Conditions	14%	51%	18%	7%	10%
(78) Low Pay	31%	42%	13%	2%	12%
(79) Poor Instructions	0%	7%	37%	47%	9%
(80) Lack of Motivation	3%	25%	45%	15%	12%
(81) Lack of Interest	7%	35%	39%	13%	6%
(82) Tight Schedules	2%	36%	42%	12%	8%
(83) Low Profit	39%	34%	18%	2%	7%
(84) Subcontractors	12%	53%	19%	9%	7%
(85) Poor Specification of Requirements	4%	8%	43%	43%	2%

COMMENT:

This is a redirection of earlier questions aimed toward the causes of non-conforming materiel. It does not ask the respondent about his plant, but rather his own opinion in a theoretical sense.

16. What do you believe is the single most effective motivational device that can be incorporated into a contract/subcontract?

(86)	CLEAR					
<u>INCENTIVES</u>	<u>REQUIREMENTS</u>	<u>PROFIT</u>	<u>PENALTIES</u>	<u>PSYCHOLOGICAL</u> <u>INCENTIVES</u>	<u>TEST</u> <u>PROGRAM</u>	<u>QUALITY</u> <u>PROGRAM</u>
35%	24%	16%	10%	10%	3%	2%

17. Do you have a specific method or procedure for determining that a contractor's/subcontractor's products are such poor quality that no more contracts will be awarded?

(87) YES 81% NO 1% BASIS IS VARIABLE 0%

If your answer is YES, please describe your method briefly?

COMMENT:

This question relates to the DoDD 4155.1 admonition to eliminate contractors with poor quality history. Eight four percent of the respondents rely on vendor rating systems. It is assumed that the contractors rating system includes a central file with subcontractors identified with their quality history.

Responses to this question generally fell into the categories shown in Question 86. Incentives are viewed in this case as profit that will be available based on performance as opposed to the singular profit entry.

18. If the following factors are considered to be measures of quality, either direct or indirect, please rate them in one of the indicated categories by circling the appropriate number.

	<u>NO MEASURE</u>	<u>POOR MEASURE</u>	<u>GOOD MEASURE</u>	<u>BEST MEASURE</u>
(88) Engineering Changes	10	32	35	1
(89) Defect Levels at Acceptance Decision Points	1	4	53	18
(90) In-process defect rates	1	6	54	14
(91) Compliance with delivery schedules	31	34	14	0
(92) Variations from life cycle cost projections	21	39	10	2
(93) Defects found at customer delivery points	0	9	52	18
(94) Customer complaints during usage	2	13	44	19
(95) Process control effectiveness	3	9	46	13
(96) Product qualification	4	19	40	10
(97) Performance Testing	0	6	51	23
(98) Receiving Inspection Results	1	19	54	8
(99) Audit Findings	3	18	50	5
(100) Scrap and Rework Cost	3	14	48	10
(101) Materiel Review Board Actions	3	31	40	3
(102) Warranty Costs	5	17	38	15
(103) Field Maintenance Costs	7	17	30	14

COMMENT:

This question relates to the "how to measure quality" issue. It is possible to assign weighting factors, e.g., No Measure = 0, Poor Measure = 1, Good Measure = 3, and Best Measure = 4, to rank the relative score for each item. If this is done, it will show scores closely grouped with the exception of 91 and 92 which rank lower. Question 104 received almost no response except for feedback which was identified 6 times. These answers are not in percentages.

19. If your firm has been provided Government furnished materiel, i.e., component, subsystem, etc., how do you perceive its impact on the quality of the delivered end item, as compared to end item quality where you provide all materiel.

(105) Improved 3%

(106) Degraded 43%

(107) No Difference 46%

No Response 8%

20. Does your company have an employee motivation program?

(108) YES 67% NO 28% NO RESPONSE 5%

21 How do you rate the following management practices in terms of their ability to motivate employees to strive for high quality workmanship levels?

	<u>NO BENEFIT</u>	<u>SLIGHT BENEFIT</u>	<u>SIGNIFICANT BENEFIT</u>	<u>BEST METHOD</u>	<u>NO RESPONSE</u>
(109) Increase Pay	15%	50%	25%	4%	6%
(110) Official Recognition	0%	4%	54%	39%	3%
(111) Improved Working Conditions	4%	41%	43%	3%	9%
(112) Varied Duties	6%	56%	28%	4%	6%
(113) Suggestion Programs	8%	55%	26%	1%	9%
(114) Long-Term Contracts	17%	29%	28%	7%	19%
(115) Special Bonus or Other Cash Awards	12%	35%	37%	10%	6%

COMMENT:

This question is aimed at identifying industrial practices to motivate operator category employees. Respondents were asked to identify other areas, no significant responses were obtained. They may also be ranked by using weighting factors as discussed in Question 18. If so ranked, official recognition will rank significantly above bonuses or other cash awards.

22. Does the accounting system in your firm accurately account for all of the following categories of quality costs?

	<u>YES</u>	<u>NO</u>	<u>NO RESPONSE</u>
(117) Defect Prevention	51%	44%	5%
(118) Defect Detection	65%	29%	6%
(119) Defect Correction (Including Warranty Costs)	63%	32%	5%

COMMENT:

The answers to this question show that quality cost accounting remains as an open quality management problem.

23. Please identify the emphasis government contract managers place on the following contract objectives by circling the appropriate number.

	<u>LOW EMPHASIS</u>	<u>MODERATE EMPHASIS</u>	<u>HIGH EMPHASIS</u>	<u>NO RESPONSE</u>
(120) Schedule	4%	12%	76%	8%
(121) Cost	4%	16%	68%	12%
(122) Quality of Materiel	23%	35%	34%	8%

24. What are your recommendations for improving the quality and reliability of the U.S. Air Force Materiel?

COMMENT:

Many respondents took this opportunity to provide recommendations and a total of 105 suggestions were received. Many were thorough and significant. There was a wide range of suggestions and the primary recommendations were, in no particular order, the following: (1) improve contracts, (2) improve technical descriptions, (3) improve contract administration procedures and upgrade personnel, (4) enforce contracts uniformly, (5) reduce paperwork, and (6) consider past performance in source selection. One respondent after listing his suggestions, added "The first time a contract is awarded because it is a quality house, then we can stop asking this question."

The fact that these recommendations have been made previously does not detract from their validity. In particular, the "improve technical descriptions" appear elsewhere in the report as a significant problem. Inadequate product description problems cannot be overcome with quality management techniques. The multiplicity of answers also indicates the problems of using uniform contracting procedures despite the different situations extant in the various management modes of different firms.

D. RESPONDENT INFORMATION AND FINDINGS

The preponderance of the respondents were professionally associated with quality assurance, 55 percent, or reliability, 19 percent. Forty six percent of them were in corporate or top level management positions with 50 percent in middle management. Seventy seven percent of the firms were aerospace product related producers. The USAF is a major customer for 48 percent of the firms and a minor customer for 32 percent. Ninety two percent of the firms have been in existence for over 20 years. Thirty three percent have experienced contracts over \$50 million and 52 percent over \$1 million in the last five years. They are principally manufacturing firms, although a significant number have been involved in research activities.

The data obtained through the questionnaire contains several biases. The middle/upper level management positions associated largely with quality assurance and reliability responsibilities can be assumed to have influenced some of the data. This is not necessarily deleterious, since their responsibilities are compatible with the study area of interest. DoD policy is not unfamiliar to these individuals and its impact is clear to them. From a motivational standpoint, the study may not accurately reflect the perceptions of the operators and lower level management personnel. In view of the product defects controllable by this group, it would be desirable to conduct a second survey aimed specifically at these individuals. Overall, the questionnaire does provide significant insight into DoD policy, product quality and reliability, and motivational relationships.

PART II - SURVEY QUESTIONNAIRE

This section contains the transmittal letter and a copy of the questionnaire employed in the study.

A. TRANSMITTAL LETTER

tec

International Technology Corporation

Dear Sir:

At the request of the United States Air Force we have undertaken an investigation into defining the factors in contracting procedures that impact on the quality of material purchased by the Air Force. We are further examining current contracting procedures to determine if improvements can be made which will improve the quality of Air Force material.

At the conclusion of our investigation we will provide our findings and recommendations to the United States Air Force for their consideration. It is possible that our conclusions will ultimately result in positive changes to current contracting procedures. We will, therefore, be most appreciative of your assistance. Obviously, the greater the spectrum of involvement by knowledgeable people, the greater the validity that can be attached to our findings. Your opinions will be included in our sample and will be treated confidentially.

We sincerely hope that you will find the necessary time to complete the questionnaire and return it in the enclosed self-addressed envelope.

Sincerely,

L. R. Webster
President

Enclosure

LRW:jac

SURVEY ON QUALITY AND
RELIABILITY-RELATED CONTRACTUAL INCENTIVES

This short questionnaire has been prepared as a part of the U.S. Air Force's continuing investigation into methods of improving the quality of material and associated contractual incentive procedures. This is a research effort. The term Quality is used in its broadest sense and is not limited to conformance to design.

This questionnaire provides a forum for you and your organization to offer specific advice to the Air Force as to what can be done to improve contracting procedures.

Your individual company responses will be confidential. A stamped self-addressed envelope is provided for your convenience.

Thank you very much for your assistance.

CONTRACT INCENTIVES FOR PRODUCT QUALITY

1. Please describe the type of products your firm is currently designing, developing, manufacturing or maintaining for your primary customers by circling the appropriate number below. For example, if you manufacture for the USAF, circle 1 in Row 1. This same method will be employed in later questions.

	<u>U.S.A.F.</u>	<u>OTHER DOD</u>	<u>OTHER GOVT.</u>	<u>COMMERCIAL</u>
(1) Electronic	1	2	3	4
(2) Air Frame	1	2	3	4
(3) Mechanical	1	2	3	4
(4) Hydraulic	1	2	3	4
(5) Munitions	1	2	3	4
(6) Propulsion	1	2	3	4
Other Products (Please Specify)				
(7) _____	1	2	3	4
(8) _____	1	2	3	4
(9) _____	1	2	3	4

2. Please describe your Quality Assurance and Reliability organization by checking the appropriate program below.

- (10) MIL-Q-9858A _____
- (11) MIL-I-45208A _____
- (12) NASA NHB 5300.4 Series _____
- (13) FAA - STD-013A _____
- (14) MIL-STD-785 _____
- (15) MIL-STD-470 _____
- (16) Commercial Standard (Please identify) _____
- (17) Other (Please identify) _____

3. Does your firm normally utilize a design review program? Please check the appropriate answer.

(18) YES _____

NO _____

4. If the answer above is yes, please indicate by circling the appropriate number which functional groups or disciplines normally participate in the review.

	<u>YES</u>	<u>NO</u>	<u>OFTEN</u>	<u>SELDOM</u>
(19) Engineering	1	2	3	4
(20) Reliability	1	2	3	4
(21) Maintainability	1	2	3	4
(22) Quality Assurance	1	2	3	4
(23) Manufacturing	1	2	3	4
(24) Your Project Manager	1	2	3	4
(25) Customer's Project Manager	1	2	3	4

5. Does your company utilize handbooks or other standard documents which provide the type of guidance shown below?

(26) Minimum quality levels to meet selected performance levels

YES _____

NO _____

(27) Minimum costs associated with selected quality levels

YES _____

NO _____

6. If your firm has had experience with any of the following contractual approaches, please indicate the impact you would expect them to have on materiel quality by circling the appropriate number.

	<u>NEGATIVE IMPACT</u>	<u>NO IMPACT</u>	<u>SLIGHTLY BENEFICIAL</u>	<u>VERY BENEFICIAL</u>
(28) Correction of Deficiencies	1	2	3	4
(29) Reliability Improvement Warranty	1	2	3	4
(30) Life Cycle Cost Incentive	1	2	3	4
(31) Value Engineering	1	2	3	4
(32) Failure-Free Warranty	1	2	3	4
(33) Quality Assurance Program	1	2	3	4
(34) Reliability Program	1	2	3	4
(35) Maintainability Program	1	2	3	4
(36) Liquidated Damages	1	2	3	4
(37) Design to Unit Production Cost	1	2	3	4
(38) Zero Defects	1	2	3	4
(39) Multi-level Acceptance Sampling Plans	1	2	3	4
(40) Reliability/Quality Incentive	1	2	3	4
(41) Performance Incentive	1	2	3	4
(42) Reliability Demonstration	1	2	3	4
(43) Draft Request for Proposal	1	2	3	4
(44) Award Fee	1	2	3	4

Other Similar Contractual Programs,
(Please Identify)

(45) _____ 1 2 3 4

7. Would/does the inclusion in a contract of any of the contractual approaches listed in Question 6 cause the Quality Assurance activities in your firm to staff or plan actions in other than the customary manner?

(45.1) YES _____ WHICH ONE(S) _____

NO _____

8. If any of the following factors have a degrading impact on the quality of materiel you produce, please circle the appropriate number.

	NO DEGRADATION	SLIGHT DEGRADATION	SIGNIFICANT DEGRADATION	SERIOUS DEGRADATION
(46) Rush Job/Schedule	1	2	3	4
(47) Subcontractors	1	2	3	4
(48) Poor Working Conditions	1	2	3	4
(49) Poor Specifications	1	2	3	4
(50) Poor Morale	1	2	3	4
(51) Job Insecurity	1	2	3	4
(52) Lack of Pride in Work	1	2	3	4
(53) Lack of Skills	1	2	3	4

Other, Please Identify

(54) _____ 1 2 3 4

9. Do you believe it is realistic to include in a contract a quality level to be achieved?

(55) YES _____ NO _____

10. If the answer to 9 is Yes, what term of specificity would you recommend?

(56) Performance Specification _____
 (57) Market Grade _____
 (58) Design Specification _____
 (59) Brand Name _____
 (60) Catalog Description _____
 (61) Part Number _____
 (62) Acceptable/Unacceptable Defect Levels _____
 (63) Other, Please specify _____

11. Would you describe the materiel that your firm builds as exceeding customer specified quality requirements?

(64) YES _____ NO _____

12. Do you feel that the inclusion of life cycle cost type of incentives e.g., Reliability Improvement Warranty or fixed price maintenance options in design/development contracts, would/does result in measurable improvement in the quality of materiel normally produced by your firm?

(65) YES _____ NO _____

13. If you were to assign responsibilities for product defects which occur in your plant, what proportion of that responsibility would you assign to each of the following categories of personnel?

(66) Corporate or Top Level Management _____ %

(67) Middle Level Management _____ %

(68) First Level Supervisors _____ %

(69) Operators or Non-Supervisory _____ %

(70) Design Engineers _____ %

TOTAL 100 %

14. How do you rate the following management techniques or methods to assure that your firm is obtaining materiel from suppliers that conforms to your requirements. Please circle the appropriate numbers.

	<u>NO BENEFIT</u>	<u>SLIGHT BENEFIT</u>	<u>SIGNIFICANT BENEFIT</u>	<u>BEST METHOD</u>
(71) Your Inspectors in Supplier's Plant	1	2	3	4
(72) Receiving Inspection	1	2	3	4
(73) Supplier Surveys	1	2	3	4
(74) Clear Definition of Requirements	1	2	3	4
(75) Financial Incentives	1	2	3	4
(76) Psychological Incentives	1	2	3	4

15. How do you rank the following factors in terms of a problem causing the production of non-conforming material? Please circle the appropriate number.

	<u>NO PROBLEM</u>	<u>SLIGHT PROBLEM</u>	<u>SIGNIFICANT PROBLEM</u>	<u>SERIOUS PROBLEM</u>
(77) Poor Working Conditions	1	2	3	4
(78) Low Pay	1	2	3	4
(79) Poor Instructions	1	2	3	4
(80) Lack of Motivation	1	2	3	4
(81) Lack of Interest	1	2	3	4
(82) Tight Schedules	1	2	3	4
(83) Low Profit	1	2	3	4
(84) Subcontractors	1	2	3	4
(85) Poor Specification of Requirements	1	2	3	4

16. What do you believe is the single most effective motivational device that can be incorporated into a contract/subcontract?

(86) _____

17. Do you have a specific method or procedure for determining that a contractor's/subcontractor's products are such poor quality that no more contracts will be awarded?

(87) YES _____ NO _____ BASIS IS VARIABLE _____

If your answer is Yes, please describe your method briefly.

18. If the following factors are considered to be measures of quality, either direct or indirect, please rate them in one of the indicated categories by circling the appropriate number.

	<u>NO MEASURE</u>	<u>POOR MEASURE</u>	<u>GOOD MEASURE</u>	<u>BEST MEASURE</u>
(88) Engineering Changes	1	2	3	4
(89) Defect Levels at Acceptance Decision Points	1	2	3	4
(90) In-Process Defect Rates	1	2	3	4
(91) Compliance with Delivery Schedules	1	2	3	4
(92) Variations from Life Cycle Cost Projections	1	2	3	4
(93) Defects Found at Customer Delivery Points	1	2	3	4
(94) Customer Complaints During Usage	1	2	3	4
(95) Process Control Effective- ness	1	2	3	4
(96) Product Qualification	1	2	3	4
(97) Performance Testing	1	2	3	4
(98) Receiving Inspection Results	1	2	3	4
(99) Audit Findings	1	2	3	4
(100) Scrap and Rework Costs	1	2	3	4
(101) Materiel Review Board Actions	1	2	3	4
(102) Warranty Costs	1	2	3	4
(103) Field Maintenance Costs	1	2	3	4

Please list and evaluate any other factors
you may consider to be measures of quality

(104) _____	1	2	3	4
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19. If your firm has been provided Government furnished materiel, i.e., component, subsystem, etc., how do you perceive its impact on the quality of the delivered end item, as compared to end item quality where you provide all materiel?

(105) Improved _____

(106) Degraded _____

(107) No Difference _____

20. Does your company have an employee motivation program?

(108) YES _____ NO _____

21. How do you rate the following management practices in terms of their ability to motivate employees to strive for high quality workmanship levels? Please circle the appropriate number.

	<u>NO BENEFIT</u>	<u>SLIGHT BENEFIT</u>	<u>SIGNIFICANT BENEFIT</u>	<u>BEST METHOD</u>
(109) Increased Pay	1	2	3	4
(110) Official Recognition	1	2	3	4
(111) Improved Working Conditions	1	2	3	4
(112) Varied Duties	1	2	3	4
(113) Suggestion Programs	1	2	3	4
(114) Long-Term Contracts	1	2	3	4
(115) Special Bonus Or Other Cash Awards	1	2	3	4
Other, Please Specify				
(116) _____	1	2	3	4

22. Does the accounting system in your firm accurately account for all of the following categories of quality costs?

(117) Defect Prevention YES _____ NO _____

(118) Defect Detection YES _____ NO _____

(119) Defect Correction (Including Warranty Costs) YES _____ NO _____

23. Please identify the emphasis government contract managers place on the following contract objectives by circling the appropriate number.

		<u>LOW EMPHASIS</u>	<u>MODERATE EMPHASIS</u>	<u>HIGH EMPHASIS</u>
(120)	Schedule	1	2	3
(121)	Cost	1	2	3
(122)	Quality of Materiel	1	2	3

24. What are your recommendations for improving the quality and reliability of the U.S. Air Force Materiel?

(123)

RESPONDENTS CONFIDENTIAL INFORMATION SECTION

PART II

1. Please circle the number that best describes your functional area of responsibility.

(124) Contract Administration

(125) Marketing

(126) Purchasing

(127) Engineering

(128) Quality Assurance

(129) Reliability

(130) Maintainability

(131) Other: _____

2. Please circle the number that best describes your position in your firm organization.

(132) Corporate or Top Level Management

(133) Middle Level Management

(134) First Level Supervisor

(135) Non Supervisory e.g., Engineer, Assembly, Inspector

3. Please circle the type(s) of business which best describes your organization:

Aerospace Product-Related Producer

(136) For Government

(137) For Airlines

(138) For Other Commercial

Non-Aerospace User/Buyer

(142) Research Organization

(143) Trade or Industry Association

(144) Government Organization

Aerospace Product-Related User/Buyer

(139) For Government

(140) For Airlines

(141) For Other Commercial

4. Please indicate what area(s) best describe your company's activities.

- | | |
|--------------------------|--------------------------|
| (145) Research | Hardware Based _____ |
| | Non-Hardware Based _____ |
| (146) Manufacturing | Prime _____ |
| | Subcontractor _____ |
| (147) Customer Sales Mix | Government (%) _____ |
| | Commercial (%) _____ |

5. How would you define your firm's business and the market environment in which your firm operates? Circle all that apply.

- (148) Limited Line of Specialized Products
- (149) Broad Line of Products
- (150) Few but Similar Competitors
- (151) Many and Diverse Competitors
- (152) High Competition
- (153) Low Competition
- (154) AF is a Major Customer
- (155) AF is a Minor Customer
- (156) Government (Defense) is Major Customer
- (157) Government (Non-Defense) is Major Customer
- (158) Government (Defense) is Minor Customer
- (159) Government (Non-Defense) is Minor Customer
- (160) Your Firm is a Major Supplier in its Market
- (161) There is no Single Major Supplier in Your Firm's Market
- (162) Firm is Defined as a Small Business
- (163) Firms age (in years) is 0-5; 6-10; 11-15; 16-20; Greater Than 20 Years Old
(Please Circle Approximate Age)
- (164) Typical Contract Size Over Past Five Years is: Greater Than
\$10,000; \$100,000; \$500,000; \$1 Million; \$50 Million
(Please Circle Approximate Size)
- (165) Market is About an Even Mix of Defense and Non-Defense
Procurements

6. May we contact you at some future date on a confidential basis to further discuss the subject matter of this questionnaire?

(166) YES _____

NO _____

7. Would you like to receive a copy of the findings of this survey?

(167) YES _____

NO _____

8. OPTIONAL - We would appreciate a response here, but it is not required.

Name/Title : _____

Address : _____

Telephone Number : _____

Firm : _____

Operating Division : _____

We appreciate your assistance in answering this questionnaire.

* * * * *

PART III - PARTICIPATING ORGANIZATIONS

The following lists identifies the industrial and government organizations that responded to the questionnaire or otherwise participated in the data collection phase of the investigation.

A. INDUSTRIAL ORGANIZATIONS (Questionnaire Respondents)

Aerojet-General Corporation
Aerojet Electrosystems Company
P.O. Box 296
Azusa, California 91702

Aerojet-General Corporation
Aerojet Liquid Rocket Company
P.O. Box 13222
Sacramento, California 95813

Aerojet-General Corporation
Aerojet Solid Propulsion Company
P.O. Box 13400
Sacramento, California 95813

Bath Iron Works Corporation
700 Washington Street
Bath, Maine

Boeing Vertol Company
P.O. Box 16868
Philadelphia, Pennsylvania 19142

Caterpillar Tractor Company
Product/Business Research Division
Peoria, Illinois 61629

Chrysler Corporation
Florida Defense-Space Operations
P.O. Box 7806
Cape Canaveral, Florida 32920

Clark Equipment Company
General Offices
Circle Drive
Buchanan, Michigan 49107

Collins Telecommunications
P.O. Box 10462
Dallas, Texas 75207

Con Edison
4 Irving Place
New York, New York 10003

Consolidated Diesel Electric Co.
1700 Post Road
Old Greenwich, Connecticut 06870

Cummins Engine Company, Inc.
1000 5th Street
Columbus, Indiana 47201

DBA Systems, Inc.
P.O. Drawer 550
Melbourne, Florida 32901

ESL, Inc.
495 Java Drive
Sunnyvale, California 94086

The Garrett Corporation
9851-9951 Sepulveda Boulevard
Los Angeles, California 90009

General Dynamics Corporation
Fort Worth Division
P.O. Box 748
Fort Worth, Texas 76101

General Electric Company
Aerospace Electronics Systems Department
French Road
Utica, New York 13503

General Electric
Space Division
P.O. Box 8555
Philadelphia, Pennsylvania 19085

General Electric Company
Armament Systems
Burlington, Connecticut 05401

Grumman Corporation
1111 Steward Avenue
Bethpage, New York 11714

Harris Corporation
Box 37
Melbourne, Florida 32901

HETRA
P.O. Box 970
Melbourne, Florida 32901

Hewlett Packard Company
1501 Page Mill Road
Palo Alto, California 94304

Honeywell Radiation Center
2 Forbes Road
Lexington, Massachusetts

Honeywell, Inc.
Government & Aeronautical Products Division
2600 Ridgway Road
Minneapolis, Minnesota 55413

Hughes Aircraft Company
Culver City, California 90230

Hughes Aircraft Company
El Segundo Manufacturing Division
P.O. Box 92426
Los Angeles, California 90009

IBM Corporation
Bodle Hill Road
Owego, New York 13827

IBM Corporation
Federal Systems Division
9500 Godwin Drive
Manassas, Virginia 22110

International Harvester Company
2200 Pacific Highway
San Diego, California 92101

International Telephone and Telegraph
100 Kingland Road
Clifton, New Jersey 07014

Kaiser Aerospace & Electronics
San Leandro Plant
880 Doolittle Drive
San Leandro, California 94577

Walter Kidd & Company, Inc.
9 Brighton Road
Clifton, New Jersey 07015

Kurz and Root Company, Inc.
236 E. N. Island Street
Appleton St., Wisconsin

Lear Siegler, Incorporated
Astronics Division
3171 South Bundy Drive
Santa Monica, California 90406

Leeds and Northrup Company
North Wales, Pennsylvania 19454

Litton Systems, Inc.
Guidance & Control Systems Division
5500 Canoga Avenue
Woodland Hills, California 91364

Lockheed Aircraft Corporation
Lockheed California Company
P.O. Box 551
Burbank, California 91520

Lockheed Aircraft Corporation
Lockheed Georgia Company
86 South Cobb Drive
Marietta, Georgia 30063

Lockheed Aircraft Corporation
Lockheed Shipbuilding
2929-16th Avenue
Seattle, Washington 98134

Martin Marietta Corporation
Canaveral Operations
Cocoa Beach, Florida 32931

Martin Marietta Corporation
P.O. Box 179
Denver, Colorado 80201

Martin Marietta Corporation
P.O. Box 29304
New Orleans, Louisiana 70189

Martin Marietta Corporation
Orlando, Florida

McDonnell Douglas Corporation
Douglas Aircraft Company, Long Beach
3855 Lakewood Boulevard
Long Beach, California 90801

Menasco Manufacturing Company
Texas Division
P.O. Box 7565
Fort Worth, Texas 76111

NCR Corporation
1700 S. Patterson Boulevard
Dayton, Ohio 45479

Northrup Corporation
3901 West Broadway
Hawthorne, California 90250

Northrup Corporation
600 Hicks Road
Rolling Meadows, Illinois 60008

Perkin-Elmer Corporation
2771 N. Gary
Pemona, California 91761

Piper Aircraft Corporation
Vero Beach Division
Vero Beach, Florida 32960

Pneumo Corporation
2220 Palmer Avenue
Kalamazoo, Michigan 49001

Q-Bit Corporation
311 Pacific Avenue
Palm Bay, Florida 32905

Raytheon Company
141 Spring Street
Lexington, Massachusetts 02173

RCA Corporation
Aerospace Systems Division
P.O. Box 588
Burlington, Massachusetts 01801

RCA Corporation
EASD
8500 Balboa Boulevard
Van Nuys, California 91406

RCA Corporation
Government Systems
Route 38
Cherry Hill, New Jersey 08358

RCA Corporation
Missile & Surface Radar Division
Moorestown, New Jersey 08057

Rockwell Collins Avionics
400 Collins Road, N.E.
Cedar Rapids, Iowa 52406

Sanders Associates, Inc.
Federal Systems Group
95 Canal Street
Mashua, New Hampshire 03061

Santa Barbara Research Center (Hughes)
75 Coromar Drive
Goleta, California 93017

GTE Sylvania, Inc.
189 "B" Street
Needham, Massachusetts 02194

TRACOR, Inc.
6500 Tracor Lane
Austin, Texas 78721

Vought Aeronautics Company
1525 Elm
Dallas, Texas 75201

Western Electric Company
Box 20046
Greensboro, North Carolina 27420

Westinghouse Electric Corporation
P.O. Box 1521
Baltimore, Maryland 21203

Westinghouse Electric Corporation
Power Systems Product Division
875 Greentree Road
Pittsburg, Pennsylvania

Wilcox Electric Inc.
1400 Chestnut Street
Kansas City, Missouri 64127

B. INDUSTRIAL ORGANIZATIONS VISITED

Aerojet-General Corporation
Sacramento, California

Communications Satellite Corporation
Gaithersburg, Maryland

General Dynamics
Fort Worth, Texas

Harris Corporation
Melbourne, Florida

Hughes Aircraft
El Segundo, California

Lockheed Missile and Space Company
Sunnyvale, California

Northrup Corporation
Newberry Park, California

C. GOVERNMENT OFFICES VISITED OR CONTACTED

Deputy Under Secretary of Defense (R&E) (Acquisition Policy) Office

Director, Contract Acquisition

Director, Material Acquisition Policy

Hq. USAF, Directorate of Contracting and Acquisition Policy

Hq. Air Force Systems Command, Directorate of Quality Assurance Policy

Hq. Air Force Logistics Command

Office of the Assistant to the Commander for
Quality Assurance

DCS/Logistics Operations, Directorate of Engineering
Services

Aeronautical Systems Division

Office of the Deputy for Contracting and Manufacturing

Office of the Deputy for Aeronautical Equipment

Office of the Deputy for Engineering

Office of the Deputy for the F-16

Office of the Deputy for the F-15

Electronics Systems Division

Product Assurance Directorate

Directorate of Engineering

Directorate of Manufacturing

Space and Missile System Organization

Quality Assurance Directorate

Reliability and Parts Control

Advanced Development

System Effectiveness

Directorate GPS Contracts

Hq. Defense Logistics Agency

Executive Directorate for Quality Assurance

Defense Material Specifications and Standards Office

Air Force Contract Management Division

Quality Assurance Directorate

Contract Administration

Engineering Program Support

Manufacturing

Armament Development and Test Center

Quality Assurance Office

Reliability Office

Department of the Navy

Special DCNM for Reliability, Maintainability and Quality Assurance

Department of Energy

Procurement Support Office

Federal Aviation Administration

Industrial Division

APPENDIX B

BIBLIOGRAPHY

This Appendix contains a listing of the reference material used in conducting the research effort.

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- Weiss, Bernard L., Observations and Recommendations to Enhance Product Quality in the Operational Environment (Quality Horizons), Air Force Systems Command, 1979

APPENDIX C

OFFICIAL DOCUMENTS

This Appendix contains a listing of the official documents which impact on the area of study. While there are numerous other non-quality assurance Directives, Specifications, Standards, etc. which affect quality and reliability, those that appear here are selected as being the most pertinent and significant.



OFFICIAL DOCUMENTS

Office of Management and Budget, Circular A-109, April 5, 1976

Office of Federal Procurement Policy, Pamphlet No. 1, August 1976

Department of Defense Directive 5000.1, March 19, 1980

Department of Defense Directive 5000.2, March 19, 1980

Department of Defense Directive 5000.3, April 11, 1978

Department of Defense Directive 4155.1, August 10, 1978

Armed Services Procurement Regulation, 1976 Edition

Department of Defense Annual Report, Fiscal Year 1980

Department of Defense, Technical Report TR-9, Zero Defects, The Quest for Quality, August 15, 1968

Air Force Regulation 74-1, June 1, 1979

Air Force Regulation 80-5, July 19, 1979

Air Force Systems Command Regulation 74-1, November 8, 1978

Air Force Systems Command Supplement to AFR 80-5, April 12, 1979

Air Force Aeronautical Systems Division Regulation 74-3, 1979

Air Force Space & Missile Systems Organization Standard 73-2C, September 2, 1975

Air Force Space & Missile System Organization Standard 73-5B, Quality Assurance Requirements for Space and Missile Systems, February 2, 1976

Military Standard 1520A, Corrective Action and Disposition System for Non-Conforming Material, March 21, 1975

Military Standard 1535A, Supplier Quality Assurance Program Requirements, February 1, 1974

Draft AFSC Quality Assurance Guidebook, February 1, 1980

Air Force Contract Management Division Regulation 74-1, Procurement Quality Assurance Program, January 3, 1977

Air Force Contract Management Division Regulation 178-1, Contractor Management System Evaluation Program, April 15, 1975